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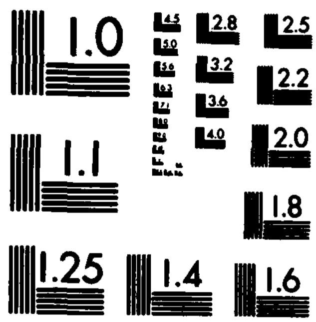

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OCTOBER TO DECEMBER 1982

SCIENTIFIC BULLETIN

DEPARTMENT OF THE NAVY OFFICE OF NAVAL RESEARCH FAR EAST

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Spin fluctuations	Integrated circuits
Magnetism	Japanese private companies R&D
Magnetic conferences in Japan	Molecular beam epitaxy
Computers	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is a quarterly publication presenting articles covering recent developments in Far Eastern (particularly Japanese) scientific research. It is hoped that these reports (which do not constitute part of the scientific literature) will prove to be of value to scientists by providing items of interest well in advance of the usual scientific publications. The articles are written primarily by members of the staff of ONR Far East,

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19. Key Words (continued)

Government-subsidized research in Japan
Magnetism
Neutron scattering
Superlattice
Molecular electronics
High temperature oxidation
Hot corrosion
Japan Institute of Metals (JIM)
Electrochemistry
Magnetism
Spin glasses
Amorphous materials
3-d magnetism
Japanese computer technology
Ministry of International Trade and Industry (MITI)
National land resources
Electronics
Telecommunications
Computer industry in Japan
Metal hydrides
Crystal structures
Phase relations
Electronic structure calculations
Korean Research Institute for Human Settlements (KRIHS)
Land development planning
Land and housing analysis

20. Abstract (continued)

with certain reports also being contributed by visiting stateside scientists. Occasionally a regional scientist will be invited to submit an article covering his own work, considered to be of special interest.

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CONTENTS

Cover: The colorful Bongsan Masked Dance is being performed in Seoul, Korea. The Bongsan dancing style is vigorous with lots of leaps and squats and broad body movements. The masks are humorously grotesque, though even less so than in the past. In Korea, masked dance drama was a way for the commoners to release their frustrations about their treatment by the upper classes and clergy, as well as a way to laugh at themselves. Contributed by the Information Attache, the Korean Embassy, Tokyo, Japan.

A further limitation on the scope of this study also needs to be noted: the lack of emphasis on work done by the Nippon Telephone and Telegraph Corporation (NTT). While, strictly speaking, it is possible to justify this omission on the ground that NTT is neither a direct instrument of GOJ policy (like MITI) nor a private corporation receiving government subsidy funds for its research (like Hitachi, Fujitsu, *et al.*). As such, its business activities and (especially) its $350 million annual R&D budget and their effects in the computer and semiconductor markets are deeply relevant to the topic of the relationship between GOJ policy measures and the competitiveness of Japanese private firms. To elaborate on this point: NTT, lacking hardware production facilities of its own must contract with private telecommunications firms, all of which are also computer companies, to build major systems or components. Under this procurement system, private companies, in addition to being encouraged to develop technologies salable to NTT, are licensed to utilize technologies developed by NTT's researchers. NTT engineers have also participated actively alongside researchers from the various private firms in the Very Large Scale Integration (VLSI) Project (which is described below as the first phase of the Fourth Generation Computer Project) and the preparatory phase of the Fifth Generation Computer Project. NTT is also working on research projects of its own which closely parallel MITI's Supercomputer and Optoelectronics projects, and quite likely there are others as well. These are some of the ways in which NTT activities may interact with the areas of research described below and are deserving of further study at a later time.

The task of evaluating GOJ subsidy programs in support of technological R&D is complicated by the multiplicity of programs, funding schemes, sponsoring agencies, and sponsoring components within those agencies. Overlapping program goals, similar sounding names for different programs, occasional variant names or nicknames for the same program, and varying English translations of Japanese program names add to the potential for confusion. Hence, listings of program names and sponsoring offices are given below for quick reference.

PROGRAMS

- High Speed Computer System for Scientific and Technological Uses ("Supercomputer" Project).

- Optical Measurement and Control System (Optoelectronic Project).

- New Semiconductor Function Elements Portion of Next Generation Industries (NGI) Basic Technologies Research and Development Program.

- Software Production Technology Development Program.

- Promotion and Development of Technology for Next Generation (Fourth Generation) Computers. [Note: This program included, as its first phase, the 1976-79 Very Large Scale Integration (VLSI) Technology Research Program.]

- Research and Development Relating to Basic Technology for Electronic Computers (Fifth Generation Computer Systems).

[Note: A seventh major project, which was funded during the 1970s and thus is included in the historical subsidy chart below, terminated in 1980 and is not covered in detail in this article. That project was the Pattern Information Processing System (PIPS) Development Project.]

SPONSORING OFFICES

Each of these programs, in addition to the technical hierarchy that directly runs it, has a sponsoring office within MITI, responsible for general bureaucratic oversight and for championing the project in the annual GOJ budget cycle. The following list gives the names (in both English and Japanese and including various abbreviations in both languages) of the MITI organs which handle these programs and the programs dealt with by each. (In the Romanization of the Japanese names of the various organizations and projects cited, a doubled vowel is used to indicated the long vowel sound; all other vowels are pronounced with the short vowel sound.)

- Agency of Industrial Science and Technology (AIST); Koogyoo Gijutsuin (Koogiin)

  National Research and Development Program (NRDP, "Large-scale Project" Program); Oogata Koogyoo Gijutsu Kenkyuu Kaihatsu Seido ("Oogata Project Seido"). (Note: This is overseen by one of the two officers within AIST's general coordination department bearing the title of Councillor for Technological Affairs.) Responsible for Supercomputer, Optoelectronics and PIPS, plus other projects which are not computer-related.

  Next Generation Industries Basic Technology Planning Office (NGIBTPO); Jisedai Sangyoo Kiban Gijutsu Kikakushitsu. Responsible for NGI Program, including New Semiconductor Function Elements.

- Machinery and Information Industries Bureau (MIIB); Kikai Joohoo Sangyookyoku (Kijookyoku)

  Electronics Policy Division (EPD); Denshi Seisakuka (Denseika). Responsible for general supervision of Software Production Technology, Fourth Generation Computers, and Fifth Generation Computers.

  Industrial Electronics Division (IED); Denshi Kikika (Denshika). Responsible for Fourth Generation Computers and Fifth Generation Computers.

  Data Processing Promotion Division (DPPD); Joohooshori Shinkooka (Jooshinka). Responsible for Software Production Technology.

PROGRAM DESCRIPTIONS

Each of the following subsections provides, for one of the subsidized programs, the most authoritative (English) title available (together with a Romanization of the most authoritative Japanese title available), as well as various abbreviations and nicknames which have appeared in the press or in other accounts. The subsequent organization in each subsection is as follows:

- a general statement of the program's goal,
- the time span during which GOJ funding is to take place,
- the GOJ organ sponsoring the program,
- the private companies participating in the program,

- the financial and organizational format within which the government-private cooperation is to take place (including arrangements for ownership of patent rights),

- government funds budgeted for the program, fiscal year by fiscal year:

  . actual Japanese figures, in yen
  . approximate U.S. dollar equivalents to the yen figures (calculated, for informal reference, at 220 yen = 1 dollar, for all years)

- a description of the general line of research to be followed to reach the goal described in the first item above,

- miscellaneous remarks relevant to the program.

SUPERCOMPUTER PROJECT

- English title — High Speed Computer System for Scientific and Technological Uses

- Japanese title — Kagaku Gijutsu Yoo Koosoku Keisan System

- Overall project goal

The speed of present general-purpose computers, about 10 million floating-point operations per second (megaflops, or Mflops), is insufficient for such scientific applications as simulation of plasma particle movements, detailed simulation of atmospheric movements, and analysis of satellite transmitted photographs. This project aims at creating a machine capable of speeds at least three orders of magnitude higher than currently attainable, that is, a 10-Gflops (gigaflops, billion floating point operations per second) computer.

- Timeframe

Nine years, JFY 1981-1989. The project was publicly announced by MITI in July 1980. Initial studies were carried out during JFY 1981, with actual R&D to begin in JFY 1982.

- Government organ sponsoring project — MITI/AIST/NRDP.

- Private companies participating in project

Fujitsu, Hitachi, Nippon Electric Company (NEC), Toshiba, Mitsubishi Electric, and Oki.

- Project financing and private sector participation format

The Association for the Development of High Speed Scientific Computers (Kagaku Gijutsu Yoo Kosoku Keisan System Gijutsu Kumiai) was formed in December 1981, by the six manufacturing companies and was commissioned by MITI in January 1982, to undertake research and development on contract for the GOJ. MITI's Electrotechnical Laboratory (ETL) will also participate in the project. The project is to be fully covered by GOJ funds in the form of consignment payments, "itakuhi," which the companies will not in parallel to achieve an overall speed of 1-Gflops. It was to have become operational in the mid-1980s.

- A newspaper account of this project (*Nikkei Sangyoo Shinbun*, 5 November 1981) predicted that "the moves for carrying out the Supercomputer Development Project through virtual cooperation between the government and private circles will probably come to irritate concerned manufacturers in the U.S. and other countries."

- Except for Mitsubishi Electric, each of the private companies participating has its own in-house supercomputer effort separate from the MITI-supported project. It is not clear at this time how these privately financed development projects within the companies will interact with the government commissioned work that will be carried out simultaneously toward similar goals by the same companies.

OPTOELECTRONICS PROJECT

- English title Optical Measurement and Control System

- Japanese title Hikari Ooyoo Keisoku Seigyo System

- Overall project goal

To create a complete system for high quality, high speed remote monitoring and control of large-scale industrial processes, using optical elements both for sensing devices (image processing) and for transmission of data in larger quantities than is possible using electrical impulses and without being subject to disturbance by electromagnetic induction.

- Timeframe Eight years, JFY 1979-1986.

- Government organ sponsoring project MITI/AIST/NRDP.

- Private companies participating in project

Fujitsu, Hitachi, NEC, Toshiba, Mitsubishi Electric, Matsushita, Furukawa, Oki, and Sumitomo Electric will be participating directly in R&D. Five other companies and a "society" are members of a research association that is part of the project's administrative mechanism. (See next paragraph.)

- Project financing and private sector participation format

The Engineering Research Association of Optoelectronics Applied Systems was established in January 1981, with membership of "one society and fourteen companies." In October 1981, the Association established the Optoelectronics Joint Research Laboratory (OEJRL), a 30 researcher, 1,600 square meter facility within the Fujitsu Laboratories in Kawasaki. Active OEJRL participants include the nine companies named in the preceding paragraph, plus researchers from MITI/AIST. The OEJRL is to be hired by the GOJ on a contract basis to do research, the results of which will be made available by GOJ to "related industries." All expenses of the project are to be covered by GOJ funds in the form of consignment payments, "itakuhi," which the companies will not be required to refund to the government. Patents obtained will be GOJ property and are available for licensing upon application to MITI'S Industrial-technology Promotion Agency.

- Budget

.	Total	18,000 million yen (projected)
	1979	51 " "
	1980	927 " "
	1981	2,418 " "
		(1,300 " " is for lab expenses)
	1982	3,238 " "
	1983-86	No information overall; OEJRL expenses projected at about 6,000 million yen

.	Total	$81,818,000
	1979	232,000
	1980	4,214,000
	1981	10,995,000
		(5,909,000 for OERJL)
	1982	14,718,000
	1983-86	No information; $27,273,000 for OERJL

- General line of research

The key to the success of the program is the development of optoelectronic integrated circuits (OEIC's), in which both optical and electronic elements are integrated monolithically. Attainment of this new device concept will require a new technology of integration, involving:

greatly improved crystal growth techniques capable of producing large-scale high quality substrates of compound semiconductors such as gallium arsenide,

advanced techniques for IC pattern processing, and

quality control methods refined enough to evaluate the products of the foregoing two processes.

- Remarks

In mid-January 1982, OEJRL announced a key success in one of its research areas, the cultivation of high-quality single crystal gallium arsenide substrates for integrated circiuts. Details of the technology were to be announced at an April 1982 meeting of the Japan Society of Applied Physics.

The official AIST prospectus for this project limits its description of the research goals to the industrial control applications mentioned above. More ambitious statements of purpose have been made; however, the *Japan Economic Review* for 15 September 1981 attributes to MITI an intention to use the OEJRL to do research leading to the creation of a "dream computer" that would use light, rather than electricity, as a medium of information transfer.

NEXT GENERATION INDUSTRIES (NGI) PROJECT

- English title — Next Generation Industries Basic Technologies Research and Development Program

- Japanese title   Jisedai Sangyoo Kiban Gijutsu Kenkyuu Kaihatsu Seido

- Overall project goal

The nurturing of "revolutionary basic technologies" essential to the establishment of new industries which are expected to flourish in the 1990s, such as aerospace, information processing, bioindustry, nuclear power, alternative energy sources, and exploitation of ocean resources. Three general fields have been chosen: "New Materials," "Biotechnology," and "New (Semiconductor) Function Elements." Within these fields, twelve specific technological "seedlings" have been selected for GOJ-subsidized research and development until they reach the "sapling" stage, at which time they can be applied in industrial processes.

- Timeframe

Ten years, JFY 1981-1990. Of the twelve subprojects, eight are scheduled to last ten years, one will be nine years, and the other three will be eight years.

- Government organ sponsoring projects   MITI/AIST/NGIBT.

- Private companies participating in projects

Thirty-three companies are working on "New Materials" subprojects, ten are working on "Biotechnology" subprojects, and 14 are working on "New Semiconductor Function Elements" subprojects. A total of forty-eight companies are involved; some companies are working on as many as five different subprojects.

- Project financing and private sector participation format

Five research associations--three in "New Materials" and one each in "Biotechnology" and "New Semiconductor Function Elements"--have been formed by private companies and have been commissioned by MITI to undertake basic research under contracts with GOJ. In addition, ten national R&D laboratories will participate in the program. Project expenses incurred by private companies are to be fully covered by GOJ funds in the form of consignment payments, "itakuhi," which the companies will not be required to refund to the government. Patents obtained will be GOJ property and are available for licensing upon application to MITI'S Industrial-technology Promotion Agency.

- Budget

.	Total	104,000 million yen
		(80,000 " " for "commission expenses")
	1981	2,714 " "
	1982	4,786 " "
	1983-90	No information
.	Total	$472,727,000
		(363,636,000 for "commission expenses")
	1981	12,336,000
	1982	21,755,000
	1983-90	No information

- General line of research

The three research areas, and the various subprojects within these areas, are as follows:

- New Materials:

  High Polymers (Research Association for Polymer Basic Technology)
  - High Efficiency Separation Membranes
  - Conductive High Polymers
  - Crystalline High Polymers

  Fine Ceramics (Fine Ceramics Technology Research Union)

  Metals and Composite Materials (Next Generation Metals and Composite Materials Research and Development Association)
  - High Performance Crystal Controlled Alloys
  - Composite Materials

- Biotechnology (Biotechnology Development Research Union)

  Mass Cell Cultivation
  Bioreactors
  Recombinant DNA Utilization Technology

- New (Semiconductor) Function Elements (Research and Development Association for Future Electron Devices)

  Superlattice Devices
  Three-Dimensional Circuit Cells
  Elements with Increased Environmental Resistance

- Remarks

According to *Denki Shinbun* for 10 September 1981, the program as originally conceived by MITI involved 16 subprojects, to cost 120 billion yen over 10 years, with a first year budget of 5.2 billion yen, but the Ministry of Finance (MOF) forced a cutback to 12 subprojects with a ten-year budget of 104 billion yen and a first year budget of 2.7 billion yen.

MITI's original budget request for JFY 1982 was 4,812 million yen. After consultation with MOF, this was cut back to a 4,714 million yen request for submission to the Japanese Diet.

This program is the first stage of the implementation of the recommendations of the Long-term Industrial Technology Planning Committee (Sangyoo Gijutsu Kaihatsu Chooki Keikaku Sakutei Kenkyuukai), a 22-member body of academics and other experts commissioned as a private consultative organ of the Director of MITI/AIST. The Committee began its study in 1977 and issued an interim report in August 1980, and a final report in October 1981. As noted above, the "Next Generation Basic Industries" R&D is to be carried out during the 1980s with the aim of going into practical application in the 1990s. The time horizon under review by the Long-term Committee extends another decade beyond that, suggesting that, over the long-term, research should be encouraged and supported in three general areas: "Microtechnology," which includes the development of ever-more-highly-integrated electronic circuits as well as genetic engineering; "Information Technology," which includes the development of increasingly human-like computer capacities through artificial intelligence techniques as well as experimentation with genetic engineering as a possible new area within information technology; and "Composite Technology," which includes advanced "mechatronics," the development of large integrated systems for the purpose of automation of industrial processes (possibly in environments, such as deep seabeds, where human attendance is not feasible).

One of the general goals behind the projects of the Long-term Industrial Technology Program is given by MITI as "making greater contributions, through technology development, to the world community of nations." Another is ensuring that Japan will not be in the future, as it has been in the past, largely dependent upon imported technology. In order to try to accomplish these two goals simultaneously, MITI is seeking ways to incorporate into the project a considerable amount of cooperation with foreign countries. (Note: *Nikkei Sangyoo Shinbun* for 12 October 1981 reported that "for the maximal display of the vitality of private enterprises, MITI thinks that it is also necessary to release to private enterprises the results of the studies made by large-scale projects under its leadership, and to conclude cross-license contracts with the advanced nations of Europe and the U.S. concerning know-how in the field of basic patents." On this point, MITI officials have told the U.S. Embassy in Tokyo that the newspaper was in error in implying that MITI had at that time reached a decision to promote international cross-licensing of patents developed in this program. Some such decision appears to have been made since that time, however.

NGI SEMICONDUCTOR PROJECT

- English title — "New Function Elements" Portion of the Next Generation Industries Basic Technologies Research and Development Program

- Japanese title — Shin Kinoo Soshi

- Overall project goals

  . Develop extremely fine lattice-structured elements capable of very high computation speeds at room temperature.

  . Develop elements with three-dimensional structure in order to increase greatly the number of functions that can be combined on a single chip.

  . Develop elements capable of functioning in space, inside atomic reactors, inside automobile engines, and in other environments which, though extremely inhospitable, must be computerized.

- Timeframe

Ten years, JFY 1981-1990, for the first two subprojects, "Ultralattice Element" and "Three-Dimensional Elements"; eight years, JFY 1981-1988, for the third subproject, "Environment Resistant Elements."

- Government organ sponsoring project — MITI/AIST/NGIBT.

- Private companies participating in project

Fujitsu, Hitachi, Sumitomo, NEC, Oki, Toshiba, Mitsubishi, Sanyo, Sharp, and Matsushita.

- Project financing and private sector participation format

The ten companies involved have organized themselves into the "Research and Development Association for Future Electron Devices" (Zaidan Hoojin Shin Kinoo Soshi Kenkyuu Kaihatsu Kyookai), which is further subdivided into research teams working on the three subprojects. MITI commissioned the Association to carry out research work on its behalf with contracts in effect as of October 1981. Project expenses are to be fully covered by GOJ funds in the form of consignment payments, "itakuhi," which the companies will not be required to refund to the government. Patents obtained will be GOJ property and are available for licensing upon application to MITI'S Industrial-technology Promotion Agency.

- Budget

Millions of yen

	Total	(1)	(2)	(3)
Total	25,000	8,000	9,000	8,000
1981	673	180	300	180 (approximately)
1982	1,128	300	500	300 (approximately)
1983-90	No information			

Thousands of dollars

	Total	(1)	(2)	(3)
Total	113,636	36,364	40,909	36,364
1981	3,059	820	1,360	820 (approximately)
1982	5,127	1,360	2,270	1,360 (approximately)
1983-90	No information			

- General line of research

"Ultralattice Elements"--Fujitsu, Hitachi, and Sumitomo Electric: After carrying out a search for appropriate materials, lamination techniques will be developed which are capable of building multiple-layered structures in which each layer is on the order of a single atom thick. Techniques will also be developed to reduce cathode-to-anode distance in individual semiconductors to less than 5,000 angstroms.

"Three-Dimensional Elements"--NEC, Oki, Toshiba, Mitsubishi, Sanyo, Sharp, and Matsushita: Methods will be developed to incorporate individual circuit elements into a chip in layers, rather than all in the same plane (as at present). This will increase the density of elements per chip by 40-50 times over present levels. Specific goals include eight-ten or more layer elements integrating logical, memory, and other functions; and five or more layer elements combining such functions as sensing and signal switching.

"Environment-Resistant Elements"--Toshiba, Hitachi, and Mitsubishi: Element, mounting, integration, and evaluation technologies will be developed with the ultimate aim of producing highly integrated (30,000 transistors per chip) IC's, IC's capable of withstanding radiation levels around 10,000,000 rads and IC's capable of withstanding temperatures of up to 300 degrees Celsius.

- Total 6,626 million yen

Total	6,626	million	yen
1976	500	"	"
1977	850	"	"
1978	1,112	"	"
1979	1,522	"	"
1980	1,672	"	"
1981	970	"	"

Total	$30,118,000
1976	2,273,000
1977	3,864,000
1978	5,055,000
1979	6,918,000
1980	7,600,000
1981	4,409,000

- General line of research Specifics not available.

- Remarks

The Software Production Technology Program was begun as a five-year, 7.5 billion yen effort, with the goal of developing a sophisticated package of software capable of generating applications programs (more or less) directly from descriptive program requirements. Early on, this extremely ambitious goal was recognized as unattainable in the course of a project of this scale, and several modifications were made: funding was cut back by nearly one billion yen, the project completion date was delayed by one year, and the original project goals were scaled down from "automatic code generation" to the creation of a library of working aids for programmers. The earlier dream of automatic program generation has not been abandoned; however, something very much like it is among the goals of the Fifth Generation Computer Project.

The main push of IPA's activities lies in promoting, through both commissioning/purchase and the issuance of credit guarantees, the production and widespread use of commercial applications programs. The just ended Software Production Technology Development Program was IPA's closest approach to sponsoring pure state-of-the-art research; other IPA activities of possible interest in a similar vein are the Software Maintenance Engineering Facility (Software Hoshu Gijutsu Kaihatsu Keikaku), a five-year, five billion yen ($22.7 million) program beginning in 1981 with the aim of reducing software maintenance costs by partial automation, and the Software Technology Center, a permanent general purpose R&D facility for the use of software engineers dispatched from various sectors of the information industry community. For the latter facility, budgets for 1981 and 1982, its first two years in existence, were 395 million and 711 million yen ($1.8 million and $3.2 million), respectively.

FOURTH GENERATION COMPUTERS PROJECT

- English title: Promotion and Development of Technology for Next Generation (Fourth Generation) Computers

- Japanese title: Jisedai (Dai-4 Sedai) Denshi Keisankiyoo Kihon Gijutsu No Kaihatsu Sokushin

- Overall project goal

Develop the basic hardware, operating system (OS) software, and peripheral equipment required for a computer comparable to the IBM "Future Series (FS)" computers in the degree to which that series is expected to surpass the memory capacity and computing speed of typical top-of-the-line computers of the early 1970s, e.g., the IBM 370 series.

- Timeframe

Phase I (Hardware), four years, JFY 1976-1979.
Phase II (OS Software, and Peripherals and Terminal Equipment), five years, JFY 1979-1983.

- Government organ sponsoring project MITI/MIIB/IED.

- Private companies participating in project

Phase I: Fujitsu, Hitachi, Mitsubishi, NEC, and Toshiba.
Phase II-A (OS development): Fujitsu, Hitachi, Mitsubishi, NEC, and Toshiba.
Phase II-B (Peripherals and Terminal Equipment): Fujitsu, Hitachi, Mitsubishi, NEC, Toshiba, Oki, Sharp, and Matsushita.

- Project financing and private sector participation format

Phase I

The five companies, plus participants from NTT and from MITI/AIST'S Electrotechnical Laboratory (ETL) constituted themselves as the Very Large Scale Integration (VLSI) Technology Research Association (Choo LSI Gijutsu Kenkyuu Kumiai). Money was provided to the Association in the form of a conditional loan "hojokin," which is often translated, somewhat misleadingly, as "subsidy"), repayable (without interest) if and when participating companies accrue profit from the technologies developed under this project. Some 29 billion yen was lent by the GOJ through this channel during the four years of the VLSI Project, with the remainder of the 72 billion yen R&D expenses borne by the companies themselves. No repayments have yet been made. Technology developed during the project is the subject of a series of about 1,000 patents, of which about 95 percent are owned by the VLSI Research Association and the remainder--those based on research done primarily by GOJ employees--are owned by MITI. Association-owned patents are available (subject to MITI/MIIB/IED approval, which has been granted essentially automatically thus far) to Association member companies for their own use or for cross-licensing to domestic and foreign companies with which they may have cross-licensing agreements. MITI-owned patents from this project are controlled by MITI/MIIB/IED, rather than the Industrial-technology Promotion Agency. The U.S. Embassy in Tokyo has been given to understand that various foreign companies are negotiating for access to these patents, but that no agreement has been reached yet.

Phase II

The participating companies incorporated themselves as the Electronic Computer Basic Technology Research Association (Denshi Keisanki Kihon Gijutsu Kenkyuu Kumiai) in July 1979. Of the 47 billion yen estimated total R&D cost of this phase, the original plan was for half to be contributed by the members of the Association and the other half provided by MITI in the form of a conditional loan like that provided to the VLSI Association. This formula was adopted for JFY 1979 through 1981; beginning in JFY 1982, however, the MITI share of the expenses was cut from 50 percent to 45 percent because of overall GOJ budgetary constraints.

- Budget

Millions of yen

Phase I		Private	MITI
	Total	42,000	29,098
	1976	4,500	3,500
	1977	13,500	8,640
	1978	13,500	10,052
	1979	10,500	6,906
Phase II			
	Total	24,500	22,500
	1979		1,700 (85 % for software development)
	1980		5,785 (85 % ")
	1981		6,200 (83 % ")
	1982		5,616 (88 % ")
	1983		No information

Thousands of dollars

Phase I		Private	MITI
	Total	190,909	132,263
	1976	20,455	15,909
	1977	61,364	39,273
	1978	61,364	45,691
	1979	47,727	31,391
Phase II			
	Total	111,363	102,272
	1979		7,727
	1980		26,295
	1981		28,182
	1982		25,527
	1983		No information

- General line of research

Six target areas were established for each of Phase I, Phase II-A, and Phase II-B. The areas are as follows:

. Phase I (VLSI)

Microfabrication
Crystal Cultivation
Semiconductor Design
Processing
Testing and Evaluation
Device Design

- Phase II-A (OS Software Development)

  "Basic Technology" (such as one level storage and control of large-scale memory
  Network Management Technology
  Data Base Management Technology
  Virtual Machine Technology
  Super High-level Language Processing
  Direct Japanese Language Processing

- Phase II-B (Peripherals and Terminal Equipment Development)

  Japanese Language Ideographic and Phonetic Script Input Technology
  Japanese Language Voice Input Technology
  Japanese Language Optical Character Reader
  Japanese Language Printing
  Large-capacity Magnetic Disks
  Large-capacity Magnetic Bubble Units

- Remarks

Phase I of this program, the VLSI Project, terminated as scheduled in JFY 1979 and has produced about 1,000 patents and some 460 technical papers which have been presented at various international conferences in the U.S., Europe, and Japan. A leading American expert on VLSI technology (cited without further identification at a seminar sponsored by the Japan Society of Northern California in May 1981) reviewed the literature and expressed the opinion that, except for the development of an evaluation technology for oxide and nitride layers using liquid crystal, the Japanese did not appear to have made any major breakthroughs. He felt that, in most areas, the Japanese had simply extended their technology in ways comparable to developments that had already occurred in the United States. A number of knowledgeable foreign observers, however, emphasize that what is important about this program, and the others described in this article, is not the number and kind of patents resulting, or the performance of resultant prototypes, or even the performance of immediate commercial applications (if any); rather, it is the value of these programs as on-the-job training exercises for Japanese engineers and scientists whose endeavors would otherwise be constrained by the commercial horizons of individual Japanese companies. This point requires further emphasis: successful innovation in computers, as in other scientific fields, generally requires experimentation, with the freedom to discard unproductive lines of research. None of the Japanese computer manufacturers, and very few of their competitors in the U.S. or elsewhere in the world, have sufficient in-house resources to allow them much of this expensive freedom. Whatever else the GOJ's joint government-private research projects (of which the VLSI Program is only the best known and best financed to date) may accomplish, providing Japanese companies this luxury may well be the aspect of the projects with the greatest long-term benefit for Japanese competitiveness in the marketplace.

FIFTH GENERATION COMPUTER PROJECT

- English title — Research and Development Relating to Basic Technology for Electronic Computers (Fifth Generation Computers)

- Japanese title Denshi Keisanki Kiso Gijutsu no Kenkyuu Kaihatsu Dai-5 Sedai Computer

- Overall project goal

Design information processing systems to deal with the basic social problems Japan foresees for itself in the 1990s (such as low productivity in primary and tertiary industries, international competition, energy and resource shortages, and a rapidly-aging population). Among the specific applications set as eventual goals for the project are:

a machine translation system automating ninety percent of natural language translation (e.g., between Japanese and English)--that is, everything except final editing and polishing--at a cost no greater than thirty percent of that of human translation.

a consultation system capable of functioning as a small interactive reference library for workers in various specialized fields such as (initially) medical diagnosis, computer-aided design of machinery, and computer system trouble-shooting.

a system capable of automatic or nearly automatic creation of software from specified requirements, with little or no need for computer sophistication on the part of the user. (Note: This is similar to the original aim of MITI's Software Automation Project, described above.)

- Timeframe

- Preliminary surveys and studies, JFY 1979-1981,
- Initial stage (Basic Technology Development), JFY 1982-84,
- Intermediate state (Subsystem Development), JFY 1985-88,
- Final stage (Total System Integration), JFY 1989-91.

Beginning with JFY 1981, the project's expenditures come from the MITI/MIIB budget. During the first two years, surveys were carried out by a special study group within the nonprofit Japan Information Processing Development Center (JIPDEC) (Nihon Joohooshori Kaihatsu Kyookai), which is said to have expended about 120 million yen. The high point of the survey period was an international conference held in Tokyo in October 1981, at which the research group from JIPDEC presented an overall outline for Japan's project and researchers from a number of other countries contributed comments. Further discussions within MITI, and between MITI and MOF, resulted in a February 1982, "Report of the Electronic Computer Basic Technology Development Investigation Committee" which is the most authoritative current description of the aims of the project as a whole. Actual progress and goals of work are to be reevaluated between the initial and intermediate stages and again between the intermediate and final stages.

- Government organ sponsoring project MITI/MIIB.

- Private companies participating in project

Fujitsu, Hitachi, NEC, Toshiba, Mitsubishi Electric, and Oki, plus two manufacturers of home electric appliances. In addition, MITI's Electrotechnical Laboratory (ETL), NTT, a number of other electronic firms, and various academic institutions have taken part in the 1979-1981 preliminary studies for the project and are likely to have eventual roles in the research.

- Project financing and private sector participation format

The Institute for New Generation Computer Technology (Shin Sedai Computer Gijutsu Kaihatsu Kikoo), an endowed research foundation, was established in April 1982, and is to be assigned by MITI the task of accomplishing the Fifth Generation Computer goals. Original members of the Institute are those listed in the preceding paragraph. Foreign enterprises are also being invited to join. As noted above, funds from 1981 on are from MITI; the money expended by JIPDEC during 1979 and 1980 came from a private fund.

- Budget

.	Total	No figure for the entire project has been announced. 10,000 million yen is projected for 1981-84.
	1981	15 " "
	1982	426 " "
	1983-91	No information
.	Total	$45,455,000 is projected for 1981-84.
	1981	68,000
	1981	1,936,000
	1983-91	No information

- General line of research

The project as a whole consists of eleven research "themes," each of which is a fairly major undertaking. The themes are organized into five groups, and the themes themselves are further divided into subthemes. The following is a summary table:

. Problem Solving/Inference Systems

- Problem Solving/Inference Mechanisms (including fifth generation core language, multiple approach problem solving mechanisms, and parallelization of inference mechanisms)
- Problem Solving/Inference Machine (including data flow machine, abstract data structure hardware mechanisms, and parallel structure inference hardware mechanisms)

. Knowledge Base Systems

- Knowledge Base Mechanisms (including knowledge representation systems, large-scale knowledge base systems, and distributed knowledge base management systems)
- Knowledge Base Machine (including relational data base machine, parallel structure hardware mechanisms for relational calculation and knowledge accumulation, and fundamental knowledge base hardware mechanisms)

. Intelligent Interface Systems

- Intelligent Interface System (including natural language processing, voice processing, diagram and image processing)
- High Capability Interface Equipment (including specialized processors for such things as voice processing)

- Development Support Systems

  - Pilot Module for Software Development (including hardware and software systems for a sequential inference machine)
  - VLSI Technology and System Architecture [including intelligent VLSI computer-aided design (CAD) system, and software and hardware development support systems]

- Basic Applications Systems

  - Mechanical Translation System (Ultimate goal is a prototype multilingual translation system with 100,000 word vocabulary, ability to handle the entire process, including editing and printing, with 90 percent accuracy; intermediate stage goal involves similar system but with 20,000 word vocabulary and 85 percent accuracy; initial stage work will be limited to translation between Japanese and English.)

  - Consultation System (Project planners hope ultimately to achieve, through the use of the knowledge base mechanisms developed in the initial stage of the project, a system with information capacity and information acquisition speed 10 to 100 times greater than those of current systems of this kind.)

  - Intelligent Programming System (including modular programming systems, metaprocedural language, module management system, algorithm bank and automatic program generation).

- Remarks

This is a highly ambitious attempt to change the whole domain of operation of computers in society from "data"--that is, abstract bits of information stored in the form of electrical impulses and manipulated by machines without regard for what they might signify--to "knowledge"--something much more like people's everyday use of the word "information" and much more accessible to people who do not have special training in computer science. What this means in practice, since the computers themselves will ultimately continue to be machines storing and manipulating electrical impulses, is that large amounts of extremely sophisticated "user friendly" software must be created to intermediate between machines and people. Such software could, in principle, be created for computers already available--indeed, much of the work to be done in the initial stage of this project will consist of using present machines to test early prototype Fifth Generation software, simulating the kind of output desired from Fifth Generation machines--but ultimately, however, a new breed of machines must be created as well.

One approach to building such new machines is to carry on the work of the past three decades in increasing storage capacity (by compressing more and more memory into smaller and smaller spaces) and operating speed (by further miniaturizing processors and devising new ways of combining processors to accomplish several tasks at the same time). The Fifth Generation Project in its final approved form contains little, if any, work of this kind; rather, administrative mechanisms will be set up to allow the Fifth Generation researchers to take advantage of exploitable new hardware developments as thay are achieved in, for example, the Supercomputer Project and the Next Generation Basic Industries Semiconductor Project. The hardware approach that will be taken in the Fifth Generation Project will focus on exploring new computer architectures designed specifically for efficient operation of the "knowledge base" Fifth Generation software.

CONCLUSION

The total GOJ subsidies--that is, outright grants--and subsidy-like expenditures --that is, long-term interest free loans with repayment required only when and if profits are achieved--for all of the R&D programs described above have been as follows over the seven-year period from JFY 1976 through JFY 1982:

Fiscal Year	Projects Underway	Billion Yen	Million Dollars	Percent Not Repayable
1976	Software Automation Fourth Generation PIPS	7.4	33.6	53
1977	Software Automation Fourth Generation PIPS	12.4	56.4	30
1978	Software Automation Fourth Generation PIPS	13.7	62.2	27
1979	Optoelectronics Software Automation Fourth Generation PIPS	13.0	59.0	34
1980	Optoelectronics Software Automation Fourth Generation PIPS	10.2	46.5	43
1981	Supercomputer Optoelectronics NGI Semiconductors Software Automation Fourth Generation Fifth Generation	10.3	46.9	40
1982	Supercomputer Optoelectronics NGI Semiconductors Fourth Generation Fifth Generation	11.2	51.0	50
Total GOJ Funding, 1976-82				
	Seven programs	78.2	355.5	38
Average Yearly GOJ Funding, 1976-82				
	Seven programs	11.2	50.8	38

According to statistics released by the Japanese Prime Minister's Office, all Japanese R&D, publicly and privately funded, in the area of "Information Processing" totalled 158.6 billion yen for 1979 and 164.6 billion yen for 1980. Dividing these sums into the yearly GOJ expenditure totals given immediately above--13.0 billion yen for 1979 and 10.2 billion yen for 1980--yields approximations for the ratio of directly subsidized programs to all Japanese programs in this field: 8.2 percent in 1979 and 6.2 percent in 1980. Any further adjustment of these approximate percentages will be downward, since our listing of subsidized R&D projects includes software development, computer systems development, and pure hardware device development, whereas the Prime Minister's "Information Processing" category omits the third of these--to make the figures fully comparable would require adding to the Prime Minister's totals the (considerable) cost of hardware device R&D work being done by private companies at their own expense--and over sixty percent of the total GOJ R&D funds provided during the seven-year period is subject to eventual repayment to the government by the recipient private firms.

The subject of participation by foreign firms in GOJ-sponsored R&D projects like those described in this article is a delicate one, with both international and Japanese domestic political ramifications. To date, there has been no direct technical participation in any of the projects described here (nor any receipt of GOJ subsidies) by any foreign owned firm. The Japanese are interested in stimulating international cooperation and exchange of information in the Fifth Generation Computer Project and have signed, or are on the verge of signing, government-to-government agreements on such cooperation with the U.K., France, and West Germany. They are also reviewing possible formulas whereby some such cooperation with U.S. researchers could be arranged.

KOREA RESEARCH INSTITUTE FOR HUMAN SETTLEMENTS
(KRIHS) AND KOREA'S TIDAL FLATS

Harley J. Walker

South Korea, with a population of nearly 40 million, has a density of more than 350 persons per square kilometer, a density greater than that for any state in the United States. Although the rate of increase today (about 1.5 percent per year) is only half that of 1960, population pressure continues. High population, when coupled with rapidly increasing industrialization and urbanization, has placed much pressure on the country's resources. Further, development to date has been regionally uneven, an unevenness that is reflected in an imbalance in economic and social opportunities around the country.

This imbalance became of such concern that the President (then Park Jung-Hee) founded the Korea Research Institute for Human Settlements (KRIHS) on 17 April 1978. It was established for the purpose of making recommendations to the government so that the most "efficient utilization and conservation of the national land resources" would be insured.

Research areas are varied and include land development planning, land and housing analyses, urban policy analyses, and national land information management (Table 1). In addition, KRIHS has fellowship and training programs and is involved in international conferences and other activities.

Established as a nonprofit organization, KRIHS receives support from the government, research grants, and contributions from both private and public organizations. Because it is such an ambitious and all-inclusive institute, it is not surprising that it has a high-ranking Board of Directors and strong advisory committees. For example, its Board of Directors is composed of a number of the government's vice-ministers such as those for Economic Planning, Agriculture and Fisheries, Commerce and Industry, Construction, and Energy among others, the presidents of the Housing Corporation, Highway Corporation, and Industrial Estate Development Corporation, and a number of the presidents of major industrial and construction companies. The General Advisory Committee, which is to advise the institute's president on the research topics that should be selected, consists mainly of presidents and chairmen of some of Korea's most important institutes such as the Korea Research Institute of Geoscience and Mineral Resources, the Institute of Science and Technology, the Korea Rural Economics Institute, and the Environmental Conservation Association.

KRIHS has an authorized staff of 118 including 90 for its research arm and 28 in administration. In 1980, the institute had 86 and 24 (a total of 110) of the positions filled. The research staff consisted of three research directors, eight senior research fellows, 15 research fellows, and 58 junior research fellows.

Some of the top scientists in Korea were attracted to these positions and now serve under the Presidency of Dr. Rho Yung Hee, the former Dean of the Graduate School of Environmental Studies, Seoul National University. The influence that the United States will have on the workings of this institute looms large if one can judge by the degrees received by the majority of the research staff. All three research directors, five of the ten senior research fellows, and five of the 16 research fellows received their highest degrees in the United States. Of these 13, ten have their doctorates. Several others have advanced degrees from Australia, England, France, and Germany. The three research directors are: Dr. Hwang Myong Chan, Ph.D. in Urban and Regional Studies, Syracuse University; Dr. Joh

Jung Joe, Ph.D. in Economics, Kansas State University; and Dr. Hong Sung Woong, Ph.D. in Regional Sciences, University of Pennsylvania.

Specific research in progress is quite varied. In the area of national physical planning, KRIHS is engaged in economic forecasting, urban development, industrial development, transportation, communication, water resources, and conservation. Within these broad categories specific tasks include studies on local industrial locations in relation to population distribution, the development of medium-sized cities, the designation of environmental conservation areas, and an economic analysis of energy development.

The main objective of this national physical planning is to develop a long-range comprehensive plan--one that can be implemented between 1982-2001. This plan, initiated in 1979, includes the establishment of guidelines for national land use reorganization by 2001 and for the eventual relocation of population and industry. A major part of this plan involves Seoul and, indeed, a comprehensive plan for the decentralization of its overconcentrated population and economic activities has already been formulated. In this connection, in 1979, the institute held an international seminar on problems associated with decentralization and also issued a volume entitled *Metropolitan Plannings: Issues and Policies*.

Also in 1979, the institute made a nationwide survey of attitudes about land ownership in order to determine the degree of understanding among Koreans about property rights and present land management systems, and in order to gather their preferences about proposed land policies.

One of the first major research projects initiated and completed dealt with the Intertidal Area Land Reclamation. Korea, especially along its western shores, has some of the world's largest intertidal areas (Wells and Huh). They cover an area of over 300 km and have been, and are being, intensively reclaimed for agricultural, industrial, and residential use.

Although dated December 1979, the publication entitled *Investigation into the Designation of the Uses of Tidal Flat Resources* did not appear until well into 1980 and then in a very limited edition. Only 100 numbered copies were printed. It is quite comprehensive, including:

- a 506-page data volume (with many oversize foldout tables),
- a map folio with 36 maps most of which are large (up to 70 x 80 cm), and
- a 144-page summary volume.

The data volume includes sections on:

- climate,
- tidal range,
- tidal flat area,
- navigation and harbors,
- solar salt pans,
- coastal population,
- coastal agriculture,
- reclamation for agriculture, and
- individual reclamation projects, among others.

The maps are of three types. The first is a set of four maps (in color) that cover the coast from north of Seoul on the west coast, south and east to north of Pusan on the southeast coast. These four maps summarize coastal reclamation plans, and in addition to the standard political designations they symbolize the coastal zones that the institute proposes be developed for harbors, industry, power plants, mariculture, agriculture, and recreation.

The second set of maps provides more detail at a larger scale. Although not in color, the patterns used are sufficiently distinctive to give a fair amount of detail (Figure 1). Thirty-six areas of the west and south coasts are represented on 26 maps. Examples are shown in Figure 2.

The third set (six maps) are provincial in scope. Although some of the information found on the other maps is repeated, the additional data add to the overall picture. These maps show such things as the locations of Buddhist temples, national monuments, migratory bird nesting areas, solar salt farms, and, possibly most importantly, the locations of sources of the rock, gravel, and sand that will be needed in dike construction.

The summary volume, although mainly text, does include some tables, graphs, and maps. The contents are quite inclusive. After presenting the rationale for the study, there are sections on:

- the present-day natural and cultural coastal landscapes,
- coastal development and the Korean economy,
- the anticipated state of the Korean economy in the year 2001,
- location and use of reclaimable land,
- the program for tidal flat development,
- and a summary of the plan.

The plan, which indeed is very ambitious, is primarily a continuation and expansion (both in the sense of area and scope) of the reclamation that has been practiced in Korea for hundreds of years. The oldest historical record of reclamation in Korea dates back to the 14th century. These early reclamation projects, initiated mainly by peasant groups, resulted in a mosaic of dikes and rice farms along selected sectors of the shoreline.

During the late 19th and early 20th centuries reclamation projects increased in number and were somewhat more systematic than had previously been the case. Much of the reclamation at this time was done by the Japanese and some of it was associated with the expansion of transportation networks.

There was not much reclamation activity during the 1930s and 1940s. However, since then the number of reclamation projects has increased greatly (Table 2). Although the government became increasingly important, Table 2 shows that private reclamation dominated into the late 1970s (Choi, *et al.*).

The plan discussed in this paper, if put into effect, will change that dominance. Whereas, during the 30-year period shown in Table 2, only 331.3 km^2 of land was reclaimed, the present plan calls for a total reclamation area of 7,270 km^2 in the next 20 years or more than 20 times as much as in the past 30 years. Of this total, only a little over one-third will be reclamation of actual tidal flat area (Table 3). The rest is shallow water land that is below water level at low tide. Nonetheless, the 2,698 km^2 of tidal flat area that it is proposed to reclaim is about 90 percent of the total tidal flat area in Korea.

The summary volume has pie charts that diagrammatically show the proposed use for this reclaimed land. The data from those charts as well as some of the volume's tables are summarized in Table 3. These data show that over two-thirds of the total area to be reclaimed will be about equally divided between mariculture and land set aside for later designation. Appropriately, the deeper water areas are more likely to be used for mariculture whereas the bulk of the area in the true tidal flat region is slated for agriculture.

In addition to the vast change in area (when completed the total area of Korea will be increased by about five percent) this reclamation will cause, there will be a major shortening of the shoreline. Although the document discussed here does not address that change, calculations of past shoreline length changes (Table 4) suggest what can happen (Choi, *et al*). Shortening results from both the closing of estuaries and bays and the connecting of islands as illustrated in Figure 2.

As mentioned, this Korean plan is very ambitious and undoubtedly will suffer many delays before being realized. However, implementation of any of its parts will drastically modify the sediment, processes, and forms along the west and south coasts of Korea. Korean coastal modification, which is already impressive, is destined to rival that of many countries, possibly even The Netherlands.

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TABLE 1. KRIHS - ORGANIZATIONAL HIERARCHY

Board of Directors

President
Auditor
Advisory Committee
Vice President

Research Department

Subadvisory Committees
Department of Policy Department

- Methodology
- Identification
- Land Policy
- Housing
- Policy
- Environmental Policy
- Policy Analysis

Department of National Land Planning

- Forecasting Indicator
- Industrial Location
- Resources Development
- Settlement Planning
- Amenity Resources

Department of Regional Development

- Regional Economy
- Public Services
- Urban Development
- Transportation Planning, Feasibility Study

Information Management Office

Program making
Library and Data Bank
Computer Management

TABLE 2. LAND RECLAMATION IN KOREA (1946-76)

	1960-60		1961-75		Totals	
	#	Area (km^2)	#	Area (km^2)	#	Area (km^2)
Governmental	28	46.9	78	85.4	106	132.3
Private	188	22.8	1275	176.2	1463	199.0
Totals	216	69.7	1353	261.6	1569	331.3

TABLE 3. PROPOSED USES OF FUTURE RECLAIMED TIDAL AREAS

	Total* Area (km^2)	%	Exposed Flats Area (km^2)	%
Mariculture	2598.3	35.7	714.4	26.4
Agriculture	1211.1	16.7	810.6	30.0
Conservation	314.5	4.3	63.7	2.4
Industry	229.1	3.2	167.9	6.2
Power Plants	216.7	3.0	152.0	5.7
Harbors	62.9	0.9	61.1	2.2
Recreation	17.3	0.2	17.3	0.6
Undesignated	2620.2	36.1	711.4	26.4
Totals	7270.1	100	2698.4	100

TABLE 4. SHORELINE LENGTH CHANGES BECAUSE OF RECLAMATION

Region	1917 (km)	1944 (km)	1975 (km)	% decrease
Han River Estuary	801.2		654.4	18.3
Asan Bay	557.4		268.8	51.8
Kyewhado	382.1	327.7	305.4	20.1

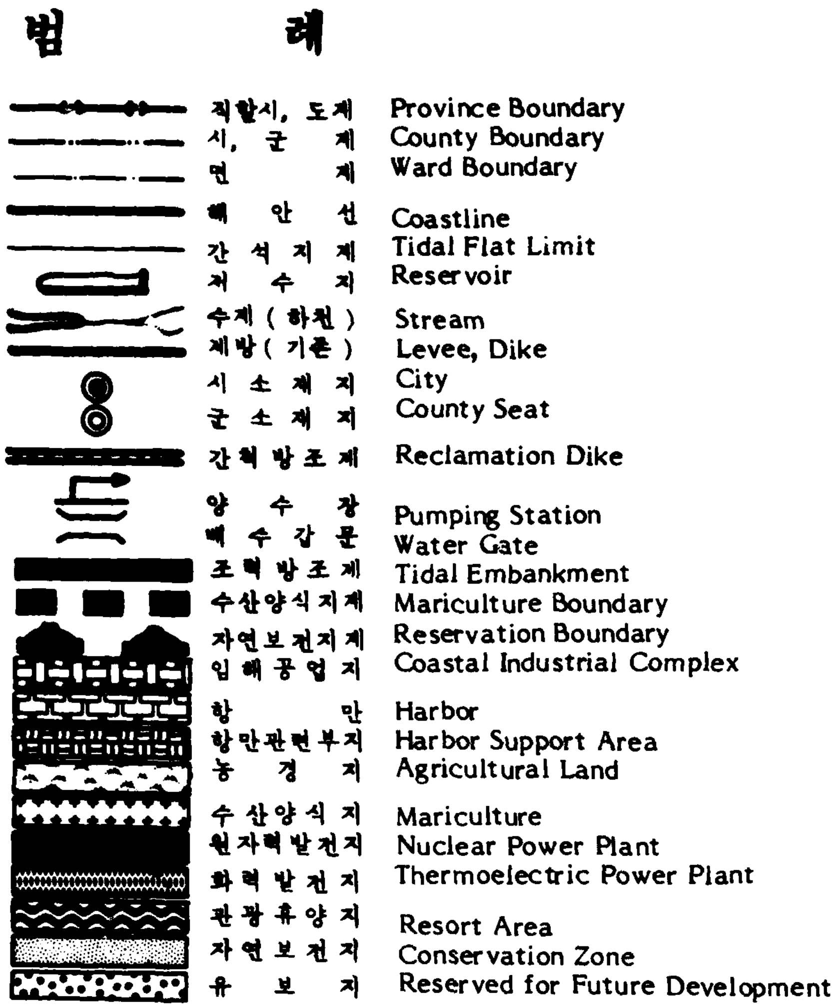

Figure 1. Legend for detailed maps of proposed reclamation.

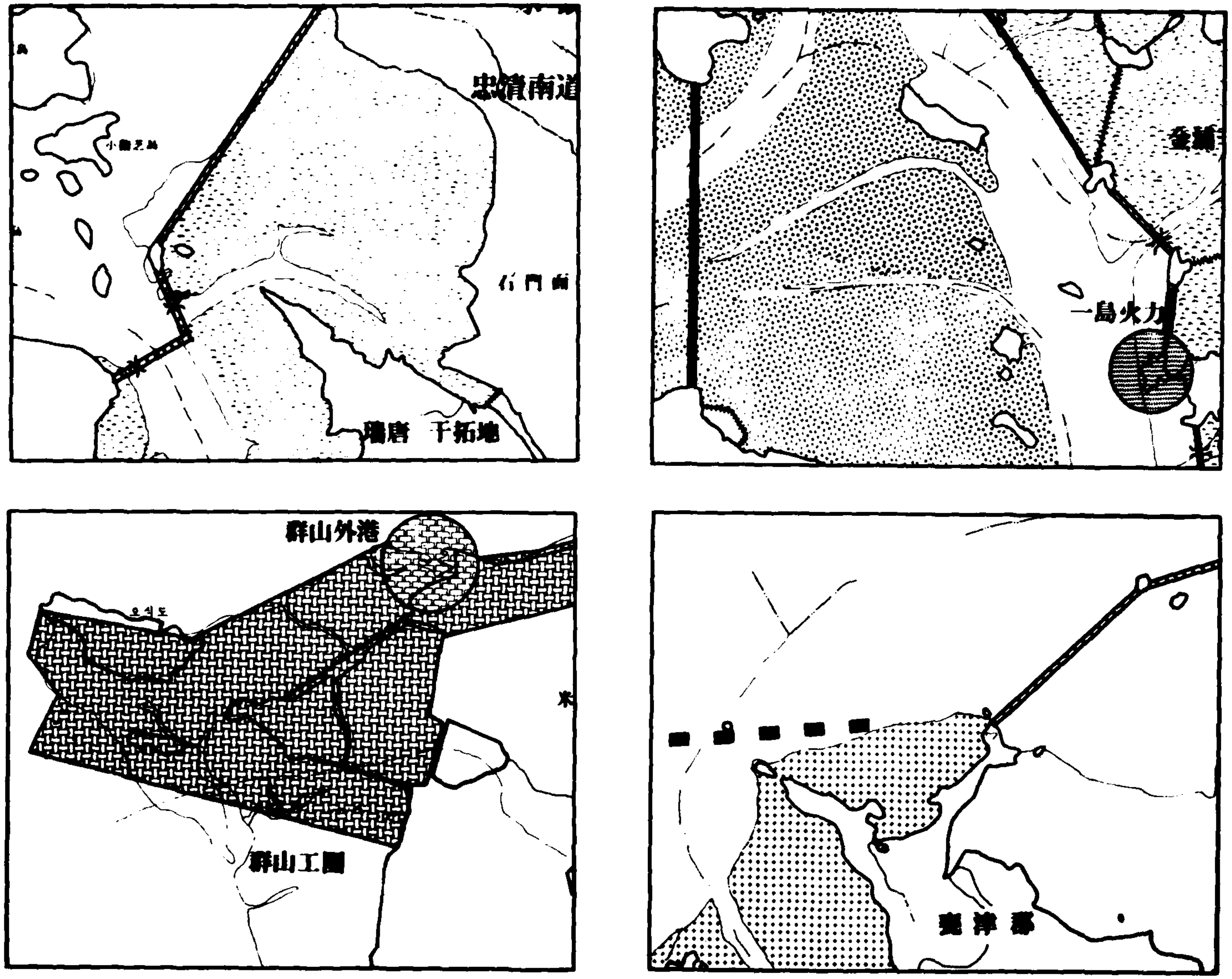

Figure 2. Examples (50 per cent reduction) of reclamation plans from 4 of the 26 detailed maps. Symbols are shown in Figure 1.

INTERNATIONAL CONFERENCE ON MAGNETISM - 1982

Michael J. Koczak and Arthur E. Clark

INTRODUCTION

The International Union of Pure and Applied Physics (IUPAP) International Conference on Magnetism (ICM) and exhibition was held at the Kyoto International Conference Hall, Kyoto, Japan, 6-10 September 1982. It was the most recent in a series of international conferences in fundamental magnetism which are held every three years. The two previous conferences were held in Amsterdam (1976) and in Munich (1979). Conference topics generally address more fundamental issues of magnetism than those of the Intermag Conference or the Conference on Magnetism and Magnetic Materials (MMM). It is also the parent of several affiliated satellite conferences (Table 1). The first four of these conferences, shown in Table 1, are discussed in separate articles.

The International Conference on Magnetism has traditionally attracted a large number of international participants. For the Kyoto Conference there were in excess of 1100 registered participants representing 37 countries. The largest number of participants are from the host country, almost 50% were from Japan and accounted for the largest fraction of the number scientists. At the conference about 9% of the registrants were from the U.S. and not quite 1% from the U.S.S.R. A total of 955 papers (55 invited) were presented, an 11% increase above the number at Munich in 1979. The program contained a great number of poster papers (754) which were held following oral sessions or symposia, with no conflict between oral sessions and poster sessions.

CONFERENCE SUMMARY

The conference provided for a mixture of plenary sessions, symposia, and panel sessions. The 55 invited talks were distributed through the conference, both as session keynote addresses and in ten symposia. The major areas of concentration were in spin glasses, amorphous materials, mixed valance systems, 3-d magnetism and spin fluctuations. These areas constitute 27 of the 87 sessions and seven of the ten symposia.

The tone of the conference was reflected in the titles of the symposia with a good deal of emphasis on spin glasses from an experimental and theoretical view point. The remainder of topics with multiple sessions included (number of sessions in parenthesis);

- low dimension systems (4),
- phase transitions (5),
- transition metals and alloys (4),
- domains (3),
- rare earth-transition metal compounds (2),
- ESR and relaxation (3),
- rare earth and actinides (3),
- magnetics and superconductivity (3),
- transition metal compounds (2),
- nuclear magnetron (1),
- transition metal alloys (2),
- magnetooptics (3),
- thin films and small particles (2),
- magnetic excitations (2),
- anisotropy and magnetostriction (2),

- NMR and Mössbauer (2),
- disordered compounds (2), and
- surfaces (2).

Two symposia were held on spin glasses, concerning experiment and theory. In the experimental session, measurements on spin glasses such as CuMn with many techniques were reported: the magnetic anisotropy of CuMn and AgMn using transverse susceptibility, electron spin resonance (ESR) and nuclear magnetic resonance (NMR) was demonstrated, the effect of spin glass ordering on the heat capacity and its temperature and field derivations was examined, and spin dynamics and relation effects were probed over a wide range of time scales from 1 to 10^{-14} sec with many techniques including muon spin relaxation and neutron scattering. In the theoretical symposium, a theory of the dynamics of vector spin glasses was developed, exact calculations on small samples of the Ising spin glass (SK model) were made and RKKY spin glasses using up to 5000 spins randomly situated on an fcc lattice were computer simulated.

In the amorphous materials symposium, recent NMR, resistivity, and Hall coefficients in metallic glasses were reviewed. Atomic and electronic structures were analyzed. Reversible and irreversible structural relaxations were discussed. In the oral sessions a significant fraction of papers reported magnetostriction and anisotropy results, and the importance of magnetostriction on the permeability aftereffect.

In the area of amorphous alloys, the experimental work appeared to be maturing with regard to studies at the microscopic level. Several participants indicated the understanding of the systems were improving, however, that no significant surprises were apparent. The invited paper by P. Allia and coworkers examined the magnetic aftereffect of amorphous Fe-Cu-B and Fe-Cr-B alloys with variable quenching rates and annealing schedules and indicated that the major source of magnetic disaccommodation is structural, and somewhat independent of, chemical compositional variations. The study of amorphous ferromagnetic ferrites by M. Sugimoto and N. Hiratsuka of Saitama University was particularly novel. A number of spinel-type ferrites were rapidly quenched, e.g., $NiFe_2O_4$, $CoFe_2O_4$ and $Mn_{0.6}Zn_{0.4}Fe_2O_4$. The amorphous magnetic properties, i.e., saturation magnetization, Ci temperature, are related to the properties of the mother crystallized ferrites. The crystallization temperature of was ~600° C, and heating below this temperature appeared to provide for an enhancement of magnetic properties. In addition, work continued to be carried out on Sm-Co, Co-Nb-B, and Fe-B amorphous materials by several investigators.

Two symposia were held on mixed valances; one based on Ce and its compounds, and one based on Sm and Tm compounds. The Kondo behavior of CeB_6 and effects of alloying with La and Y plus superconductivity in $CeCu_2Si$ were presented. Fermi surface geometry measurements were made in $CeSn_3$ and its normal valent analogs $LaSn_3$. A wide variety of experiments were performed on the intermediate valence compounds TmSe, SmS, and SmB_6. Ultrasonic measurements on semiconducting $TmSe_X Te_{1-X}$ compounds yield a negative C_{12}. Some $Tm_{1-X}Eu_XSe$ compounds were discussed as ferromagnetic semiconductors.

Clearly, there is still strong interest in the ferromagnetism of 3-d metals. T. Moriya in the first plenary session opened by discussing the controversy between the localized itinerant electron pictures. A panel discussion on 3-d magnetron plus two symposia, one on spin fluctuations and the other solely on 3-d magnetism reflected the current interest in this area. In addition, the session on magnetovolume effects and a significant portion of the satellite conference on "Magnetoelasticity in Transition Metals and Alloys" were devoted to itinerate electron magnetism. Recent progress in spin-polarized photoemission was reviewed in a separate session on many body effects.

The invited speakers in the plenary sessions included the topics:

- "Magnetooptics and its Uses," by J. F. Dillon Jr.,
- "Itinerant Electron Magnetism," by T. Moriya,
- "Organic Superconductivity," by D. Jerome, and
- "Recent Developments in Solid Earth Sciences," by S. Uyeda.

One of the more interesting experimental papers was presented by Dr. Tonomura from the Hitachi Central Research Laboratory. After the conference, several scientists visited the Hitachi Central Laboratory, which is located at Kokubunji, Tokyo 185. Dr. Akira Tonomura introduced the unique experimental technique of electron holography which allows the observation flux lines within thin films, e.g., nickel, permalloy, and particles, e.g., cobalt, as well as the observation of leakage flux lines. In the presentation, Dr. Tonomura provided a seminar involving the "Observation of Magnetic Domain Structure," and Dr. Fujiwara discussed the "Confirmation of the Abaronov-Balm Effect." The technique of electron holography, Figures 1 and 2, appears to be an improvement over Lorentz microscopy which requires defocussing of the specimen electron image. As a result, high resolution images observed with the structural details in focus coupled with a visualization of the magnetic lines of force are provided (Figure 3). Although the concept of electron holography had been proposed by Gabor[1] and Cohen[2] the concept has been recently developed by the Hitachi group[3]. Two recent papers, "Electron Holography Technique for Investigating Thin Ferromagnetic films,"[4] "Direct Observation of Fine Structure of Magnetic Domain Walls by Electron Holography,"[5] describe the details of the experimental procedure as well as a discussion of the limitations. In brief, the technique utilizes a field emission electron microscope with a Mollenstedt electron biprism (Figure 1), which generates an image hologram. An example of the reconstructed interference technique is provided in Figure 3. The electron image is reconstructed optically in a second step, as shown in Figure 2, utilizing a He-Ne laser and a beam splitter. The technique although apparently in the early stages of application provides for a clear improvement over Lorentz microscopy techniques. The approach appears particularly useful for the effects of magnetic contain lines near Neel and Bloch walls. A comparison of the two imaging techniques is provided in Figure 3. Some limitations of the technique appear to occur with variations of specimen thickness, stray magnetic fields and variations in the holograms resulting from the electromagnetic lens system and optical reconstruction. Nevertheless, the new technique of electron holography provides for an unique advance in the area of coherent electron optics.

In the area of new materials, organic superconducting materials based on Bechgaard salts of the form $(TMTSF)_2X$ where $X=ClO_4$, PF_6, Sf_6 and TaF_6 received specific attention in the plenary lectures and special symposia. The materials appear to be anisotropic superconductors in specific temperature and pressure ranges, e.g., 2 K, 6Kb. There appears to be controversy with regard to the temperature range and extent of superconductivity which appears to be altered by the crystallinity and chemistry of the samples. An overview was provided by D. Jerome as well as symposium lectures by P. M. Chaikin, J. B. Torrance, and W. M. Walsh, Jr.

As excellent review of the conference papers was given by K. Yoshida in the closing session. He cited nine areas of progress: ferromagnetism of 3-d metals, rare-earth metals compounds, low dimension systems, random systems, surface magnetism, magnetism and superconductivity, Kondo problem, diamagnetism and nuclear magnetism. Professor

Yoshida was followed by S. Methfessel who discussed the recent trends in magnetism. He pointed out that new pictures and theories are emerging for disordered systems-a result of a trend from research on 'single crystals' to 'disordered systems.' He cited the role played by magnetic phenomena and materials is almost all modern technology. V. Jaccarinv closed the conference by speculating on the future of magnetism and the ICM. He stated that because of two very important ingredients:

- a meaningful continuity, and
- the everpresent excitement of new discoveries,

magnetism has always been on the frontier of science. He emphasized that magnetism is an experimentalist's heaven as well as an excellent testing ground for theories, such as those in statistical physics. The conference terminated with a forward look to the San Francisco ICM in 1985.

ICM CONFERENCE EXHIBITION

The exhibition associated with the International Conference on Magnetism provided a view of the industrial application of magnetic materials. In general, the areas were divided into five groups:

- Fe-Si transformers steels,
- permanent magnetic applications, Alnico, ferrite, rare-earth and Fe-Cr-Co magnets,
- magnetic and electrical materials, e.g., Mn-Zn spinel-type ferrite single crystals, e.g., 90 mm in diameter and 800 mm in length, ultrafine metal powders Fe-Co, 200 A in size,
- devices, e.g., tape heads, superconducting magnets, and bubble memories,
- experimental equipment for magnetic measurements, e.g., magnetometers.

In the area of transformer steels, Fe 3.0 - 6.5 w/o Si, Kawasaki Steel Corporation and Nippon Steel Corporation had exhibits with regard to conventional grain oriented silicon steels as well as roller quenched high silicon steels. The effects of surface insulation coatings, e.g., Fosterite (Mg_2 SiO_4), has been shown to alter domain orientation and spacing. Studies at Kawasaki Steel Corporation have examined Fe-6.5 w/o Si steel ribbons produced by a single roller and twin roller techniques widths varied from 5-50 mm and thicknesses from 30-300 m. During annealing grains of the (100) [Okl] orientation grow abnormally. With a texture approaching (100) [001], magnetization and dc coersive force properties are improved. Studies at Nippon Steel have examined laser processing of commercial high permeability grain oriented silicon steel, with a (110) plane paralled to the surface and a [001] rolling direction. The laser treatment involved generation of a matrix of vaporized spots on the sheet surface. Spot diameters were 0.15 mm and a nearest neighbor spacing of 0.3 mm. The domain structure was refined to a finer size and provided for an improvement in the (110) [001] texture. Nippon Steel indicates that transformers have been developed using laser treated steels and core losses have been reduced by more than 10%. A drawback of the process is the damaged insulated surface of the steel. An additional paper presented by Kawasaki Steel involved the influence of grain orientation on the 180° domain wall spacing in (110) [001] grain oriented Fe-3% Si steel with high permeability. It was not clear from the discussions with Kawasaki and Nippon Steel representatives if any inroads have been made in the roller quenched silicon steels vs. conventional processed strip steel. However, considering the paucity of information on roller quenched steels at the technical sessions as well as the exhibition, at the moment the emphasis appears to directed to the improvement of conventionally processed strip.

In the area of electronic materials, a number of manufacturers offered a range single crystals, hot pressed (~99.9% density) and sintered (99% density) Ni-Zn or Mn-Zn ferrites, e.g., Hitachi. In addition, rare-earth magnets were provided in a resin bonded matrix, e.g., Suwa Seiko, samarium cobalt magnets, cobalt rare-earth magnets by Namiki and Shin-Etsu. Tohoku Metal Industries, Ltd., also known as Tokin, offered a range of audio/video core materials, magnetic shield case materials. Permalloy, i.e., Fe-Ni alloys and Sendust®, i.e., an Fe-Al-Si alloy were also available in sheet form. In addition, $BaTiO_3$, $CaTiO_3$ ceramic material titanates and MnZn, NiZn ferrites were also available. Research concerning lead-molybdate and ferrite single crystal materials is also being pursued at Tokin. Apart from providing the ferrite and metal products, Tokin supplies devices based upon these materials developments, i.e., ultrasonic transducers, ferrite cores, permanent magnets and thermal sensors.

With regard to experimental equipment for laboratory, geomagnetic, and ocean bed monitoring, Shimazu Corporation, the Process Instrumentation Division, located at Shinjuku, Tokyo, Japan, featured magnetometers with three axis sensing as well as magnetic gradiometers. The Denshijiki Industry Company, Ltd., located at Shibuya-ku, Tokyo, Japan, had a variety of magnetic test equipment including automatic recording devices of dc magnetic response, nondestructive evaluation equipment for large components, e.g., railroad axles, connecting rods, as well as conventional thickness gauge and magnetic particle evaluation instrumentation. In addition, the Nihon Denji Sokki Company, Ltd., located at Tachikawa, Tokyo, Japan, and the Riken Denshi Company, Ltd., locted at Meguro-ku, Tokyo, Japan, offered ranges of instrumentation including vibrating sample magnetometers, automatic ac B-H looptracers as well as corrosion meters. Sumitomo Electric, of Osaka, Japan, had a variety of superconducting magnets utilizing Nb_3Sn or NbTi; filaments with Cu-Ni barrier coatings and a copper matrix. The superconducting magnets ranged in sizes to the largest model with a height of 600 mm, an inside diameter of 360 mm and a outside diameter of 650 mm.

The conference proceedings will be published by the:

North-Holland Publishing Company
Molenwerf 1, P.O. Box 211
1000 AE, Amsterdam
The Netherlands.

In addition, the *Journal of Magnetism and Magnetic Materials* can provide further details.

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2. M. S. Cohen, J. Appl. Phys. *38*, 4966, (1967)

3. A. Tonomura, T. Matsuda, J. Endo, H. Tadokoro, and T. Komoda, J. Electron Microsc. *28*, 1 (1979)

4. A. Tonomura, T. Matsuda, H. Tanabe, N. Osakabe, J. Endo, A. Fukuhara, K. Shinagawa and H. Fujiwara, Phys. Rev. B *25*, 6799 (1982)

5. A. Tonomura, T. Matsuda, J. Endo, T. Arii, and K. Mihama, Phys. Rev. Lett, *44*, 1430 (1980).

TABLE 1

MAGNETIC CONFERENCES IN JAPAN - 1982

- International Conference on Neutron Scattering of Condensed Matter - The 67th Yamada Conference, September 1-4, 1982, Hakone (Japan),

  Professor S. Hoshino
  Institute for Solid State Physics
  University of Tokyo
  7-22-1, Roppongi, Minato-ku
  Tokyo 106, Japan

- International Meeting on Transition to "New Type of Ordered Phase," September 11-13, 1982, Kyoto (Japan),

  Professor T. Haseda
  Faculty of Engineering Science
  Osaka University
  Machikaneyama 1-1
  Toyonaka 560, Japan

- International Symposium on High Field Magnetism, September 13-14, 1982, Osaka (Japan),

  Professor M. Date
  Faculty of Science
  Osaka University
  Machikaneyama 1-1
  Toyonaka 560, Japan

- The Second Molecular Beam Epitaxy and Clean Surface Techniques Conference, August 27-30, 1982, Tokyo, sponsored by the Japan Society of Applied Physics, Professor R. Ueda, University of Tokyo, Chairman.

- The 7th Sagamore Conference on Charge, Spin, and Momentum Densities, August 25-30, 1982, Nikko (Japan),

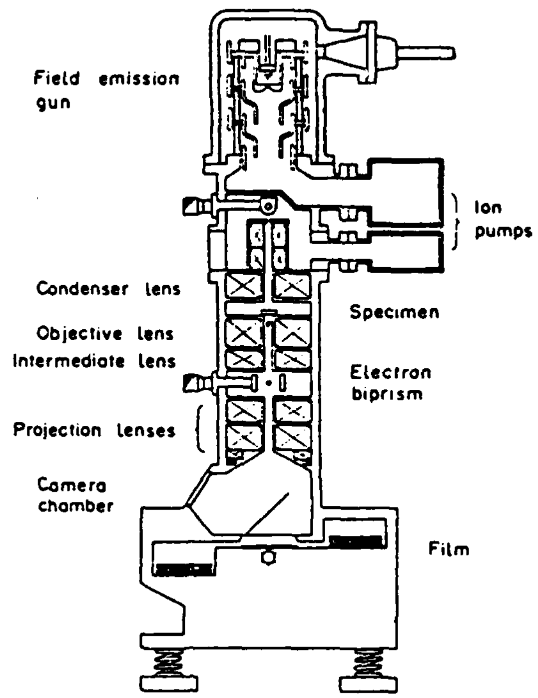
  Professor Y. Saito
  Department of Chemistry
  Faculty of Science and Technology
  Keio University
  3-14-1 Hiyoshi, Kohoku-ku
  Yokohama 223, Japan

- The 10th International Colloquium on Magnetic Films and Surfaces, September 13-16, 1982, Yokohama (Japan),

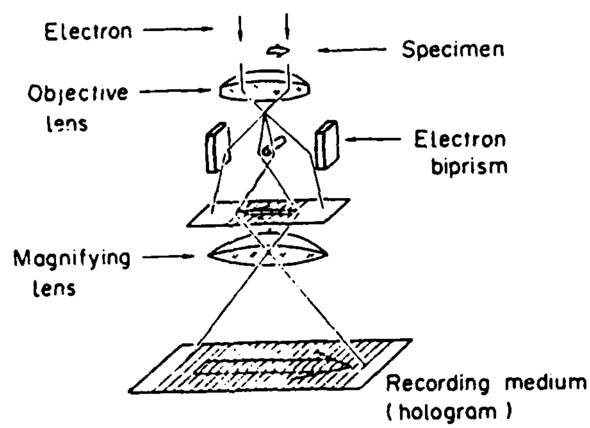
  Professor Y. Gondo
  Faculty of Engineering
  Yokohama National University
  156 Tokiwadai, Hodogaya-ku
  Yokohama 240, Japan

- International Symposium on Magnetoelasticity in Transition Metals and Alloys, September 15-16, 1982, Nagoya (Japan),

  Professor M. Shimizu
  Department of Applied Physics
  Nagoya University
  Furo-cho, Chikusa-ku
  Nagoya 464, Japan.

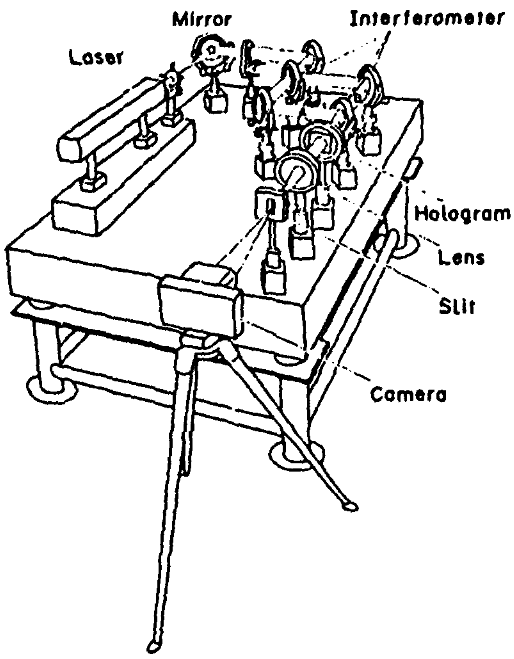


(a) Electron Lens System For Holography

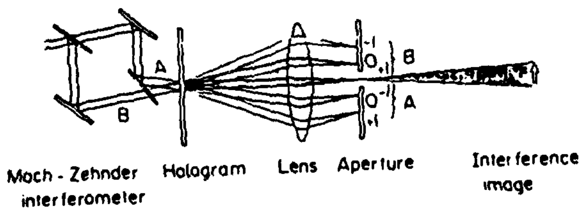


(b) Electron Biprism

Figure 1. Details of Electron Hologram Lens System (courtesy of Dr. Akira Tonomura, Hitachi Central Research Laboratory)



(a) Schematic of Optical Lens System



(b) Details of Image Formation

Figure 2. Optical Reconstruction System for Interference Microscopy (courtesy of Dr. Akira Tonomura, Hitachi Central Research Laboratory)

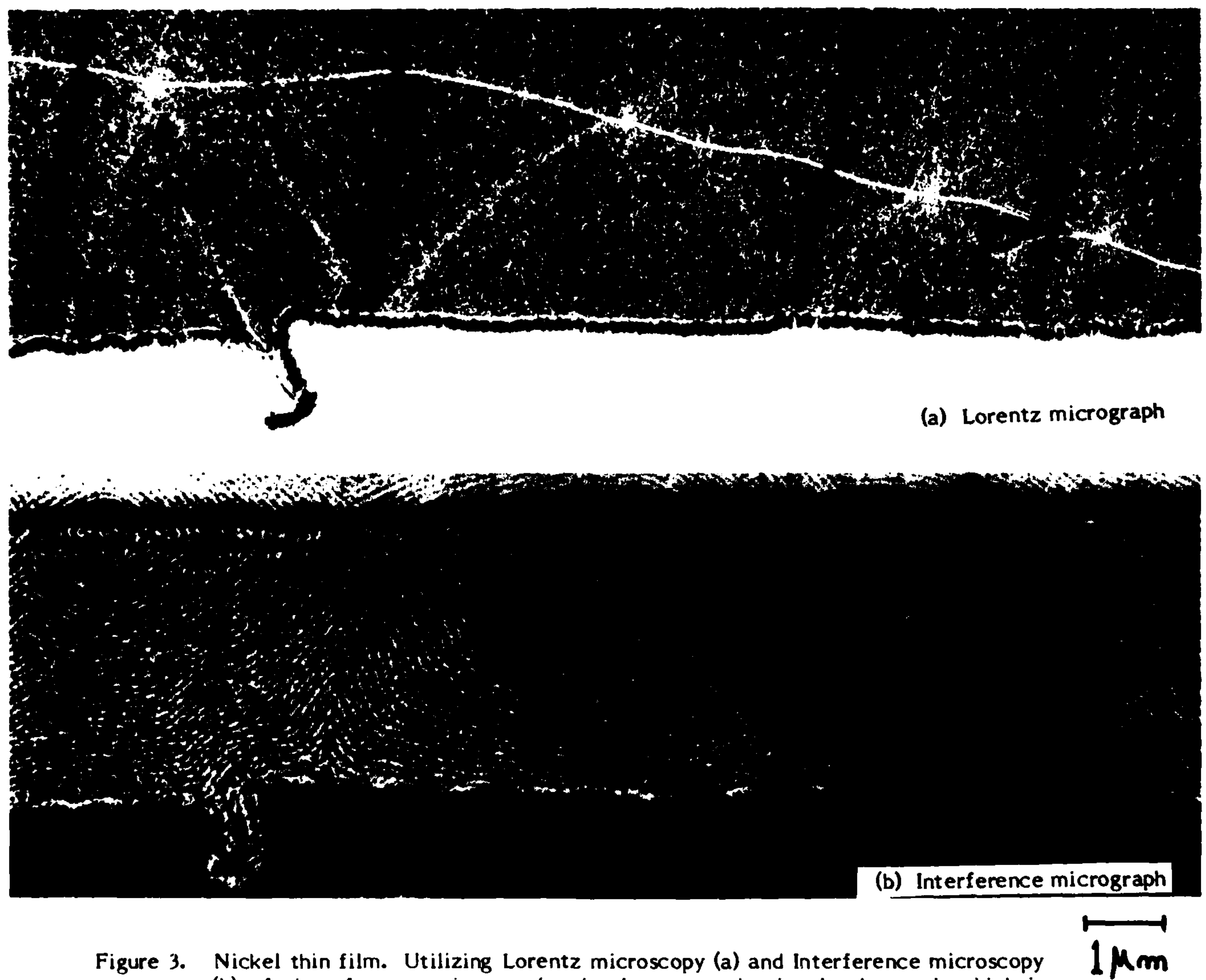


Figure 3. Nickel thin film. Utilizing Lorentz microscopy (a) and Interference microscopy (b). In interference micrograph, circular magnetization is observed, which is barely possible by Lorentz microscopy. (Courtesy of Dr. Akira Tonomura, Hitachi Central Research Laboratory)

THIRD JAPAN INSTITUTE FOR METALS INTERNATIONAL SYMPOSIUM ON HIGH TEMPERATURE CORROSION OF METALS AND ALLOYS

Michael J. Koczak

INTRODUCTION

The area of high temperature oxidation and hot corrosion was examined in a three day conference held under the auspices of the Japan Institute of Metals, (JIM), on 17-20 November 1982. Previous JIM special conferences included the First JIM International Symposium on New Aspects of Martensitic Transformations, Kobe, Japan, 1976, and the Second JIM International Symposium on Hydrogen in Metals, Minakami, 1979. Conference proceedings may be obtained by contacting the Japan Institute of Metals, Aoba, Aramaki, Sendai 980, Japan.

The rather specialized conference had an attendance of 130 scientists, with backgrounds in oxidation, electrochemistry, materials and metallurgical engineering. Apart from the Japanese participants, the two major foreign contingents included 14 scientists from the People's Republic of China and 11 from the United States. Additional foreign participants were from Great Britain, France, West Germany, Norway, Turkey, Czechoslovakia, Russia, India, Canada, Iran, Venezuela, and Italy.

The motivation for improved oxidation and hot corrosion protection is clear based upon the higher performance requirements of aircraft and land based power generation systems. As a result of higher engine efficiencies achieved by increased operating temperatures, aircraft gas turbine alloys could sustain longer lives and/or more demanding operating temperatures with effective oxidation/corrosion coatings or by appropriate alloy design. In land based power generation systems, the corrosion problems associated with coal fluidized bed operations and oxidation/sulfidation problems in coal conversion plants were addressed and remains a problem of keen interest. In the realm of nuclear power plant operation, oxidation behavior of stainless steels and Ni-Cr alloys at low partial pressures of oxygen and in liquid lithium environments was also considered. In summary, the conference deliberated on three levels:

- fundamental studies of oxidation/hot corrosion studies of pure metals and involved investigations in the transport mechanism of anion and/or cations through the surface films,

- the developmental studies of commercial alloys and coatings and their resistance to sulfidation, oxidation, phosphorus, chlorine, and vanadium rich atmospheres, and

- the mainly industrial research studies of alloys in prototype or on-stream applications, e.g., coal fired burners.

A problem cited by many participants was the lack of mechanical property information associated with the degradation of the alloys and the difficulty of life prediction.

CONFERENCE SUMMARY

The invited lectures addressed fundamental studies regarding oxide and sulphide defect structures and transport mechanisms in oxides and sulphides, (P. Kofstad); electrochemistry of hot corrosion, (R. Rapp); and the influence of secondary processes on scale formation, (S. Mrowec) The invited lectures which addressed the application of alloys to oxidation/hot corrosion environments included:

- alloy design from hot corrosion (G. R. Wallwork),
- erosion-corrosion coatings for superalloys (F. Pettit),
- high temperature corrosion for fluidized beds (J. Stringer), and
- high temperature corrosion of Fe alloys in low sulfur pressures, (K. Nishida).

Two concurrent sessions examined the fundamentals of oxidation and hot corrosion, oxidation, sulfidation of alloys as well as coatings and specific corrosion problems, e.g., boiler, nuclear plants, and chemical plant corrosion. The sessions on oxidation comprised of twenty papers, with seven examining the fundamendals of oxidation of pure metals, e.g., Ni, Fe, Cr, Co, Cu with emphasis on newer microanalysis techniques to study the oxide chemistry and transport mechanisms with regard to classical Wagner theories and growth kinetics. The study of metal/metal oxide lattice disregistry and interfacial accommodation was considered by Pieraggi. He postulated a coincident site lattice which may lead to the prediction of epitaxial relationships, interface description with regard to a dislocation network structure and the magnitude of elastic deformation at the interfacial boundary. The theory had been applied to the Ni/NiO, Fe/FeO, and Ti/TiO_2 systems. The studies by M. Yamawaki of the University of Tokyo considered additions of Al, Ti and Cr to vanadium in order to improve oxidation resistance. Vanadium is a promising candidate for the first wall in the fusion reactor, however, its oxidation resistance must be improved. Oxide layers of less than one micron have been formed between the metal and a vanadium oxide surface layers. In this study, 5-10 at.% additions were examined at temperatures from 800 to 993°K. The chromium addition was found to be the most effective and titanium least promising of alloy modifications considered. Other oxidation studies in pure metals considered the rather more fundamental aspects of oxide scale formation, transport mechanisms, and kinetics.

The oxidation studies of alloy systems had a strong emphasis in iron based alloy systems, e.g., Fe-25wt.%Cr, 12wt.%Ni; Fe-9wt.% to 18wt.%Cr alloys; Fe-30wt.%Ni as well as 304, 310, 347 stainless steels. The study by Ikeda and coworkers at the National Research Institute for Metals indicates that the mass loss of 304 stainless steel with boron and nitrogen additions is less that 304 without the additions as well as 321 stainless steels. Studies in the People's Republic of China by Z. Z. Huang and R. Z. Zhu involved high temperature oxidation of low alloy steels, e.g., Fe-12wt.%Si with Mo, V, Ni, and Al additions; Fe-12wt.% Al with Mo, and V additions; Fe-5wt.%Cr with Mo in the temperature range from 500°C to 800°C. Studies of Fe-20wt.%Cr-4wt.%Al with small additions of Sc, Y, and Er were presented by T. Amano *et al.*, from Tohoku University. Other studies reported involved cyclic oxidation behavior of Fe-11wt.% to 15wt.% Al with additions of Y and Zr, as well as alloy design studies on Fe-5M-C steels, with carbon ranges varying from 0-1.2wt.%, where 5M% alloy additions of Cr, Ti, W, V, Nb, Ta, Ni, and Si were considered. Weight loss of the alloys was primarily dependent on carbide stability with W, Nb, Ta, and V systems showing best performance.

The studies in the area of hot corrosion involved seventeen papers with a range of experimental techniques from crucible immersion to burner-rig testing. In invited lectures, the electrochemistry of hot corrosion was reviewed by R. Rapp. Professor C. R. Wallwork of the University of New South Wales, examined alloy design for hot corrosion in terms of oxide mapping in Fe-Al-Mn ternary systems. Wallwork and Newburn indicated that the nickel base alloys were not as effective as iron based alloys with regard to hot corrosion. In the system they examined, ferrous alloy chemistries containing 6-8wt.% Al and ~10wt.% Mn appeared to have the best overall performance. The alloy chemistry modification in the alloy design process is based on the formation of an effective Al_2O_3 scale formation coupled with the avoidance brittle iron aluminide and β-Mn embrittling phase as well as an α/γ duplex structures.

In the area of hot corrosion of nickel based alloys, reviews were presented by S. T. Shih on protective coatings and F. S. Pettit on erosion/corrosion studies in high velocity gas streams. In the contributed papers, particular emphasis was placed on the effects of sulfur and vanadium and their attack on ferrous and nickel based alloy power system components. The problem has quite practical applications as a result of the indigenous coal chemistries with high sulfur contents. Other studies considered combined corrosion of sulfur and chlorine on Fe-Cr-Al and Fe-Cr-Ni alloy systems. In the area of high temperature nickel based alloy systems, C. W. Corti of Johnson Matthey Research examined the role of Pt group elements upon the corrosion response in the temperature range of 750 to 900°C. Alloys have been developed which are modifications of MarM 200 and IN792 chemistries. The platinum additions ranged up to levels of 10% and questions concerning the economic viability of such systems and the mode of utilization were justifiably raised. A platinum modified nickel based alloy RJM 2012, containing 4.6wt.% Pt, showed improved stress rupture, sulphidation, and oxidation response over IN792, B1925 and Mar M 002. In addition, other surface coatings of superalloys were considered, silicon modification of superalloy coatings, i.e., $Ni_6Cr_2Si_2$ in a γ matrix, were examined by E. Fitzer and J. Daimer at the University of Karlsruhe. Also, pack aluminized coatings were investigated by M. Chigasaki *et al.* at Hitachi Research Laboratory, on Mar M 247, Rene 80, IN 738LC and V-500 in binary and ternary sulfate/chloride environments. The effect of ternary salt/sulfate mixture attack was found to be more severe versus the binary sulfates. Hot corrosion studies by the People's Republic of China examined the influence of various levels of cobalt and cobalt-free superalloys as well as lanthanum substitution for cobalt. Of particular interest was the study on a two-layer thermal barrier coatings by H. Takeda and coworkers at Toshiba Research and Development Center. Above a nickel superalloy base was a NiCr, NiCrAlY, or a CoCrAlY intermediate bond layer. The final layer, a thermal barrier coating consisted of a ZO_2 + 20% Y_2O_3 or ZO_2 + 8% Y_2O_3. The addition of an ~1.5 μm platinum layer, between the ceramic and the intermediate base layer, provides for improvements in hot corrosion and thermal fatigue properties. In general, the emphasis on the high temperature alloys involved oxidation, studies at temperature above 900°C and sulphidation reactions below 900°C.

The study of sulphidation reactions were considered by W. Worrell, K. Natesan, and K. Okada with regard to a mixed O_2/SO_2 atmospheres. Interest in nickel based systems, involved the kinetic and thermodynamic studies of NiO and Ni_3S_2 scale formation. The reduction of sulphidation reactions in nickel base systems may be assisted by a preoxidation treatment and the formation of NiO. Studies at the Tokyo Institute of Technology by M. Taniguchi *et al.*, involved sulphidation studies, i.e., H_2S/H_2, of vanadium. Additional studies on H_2S/H_2 reactions in Fe-Cr systems were investigated by T. Narita of Hokkaido University. Additional studies examined sulphidation reactions in Fe-Ni, Fe-Al, Ni-Cr + 1%Y, Ni-Al + 1%Y and a range of 347 stainless steels, e.g., Fe-18Cr-10Ni with additions of Nb, Ti, and Mo. The study on the 347 stainless steel by H. Makiura of Sumitomo Metals confirmed the beneficial effects Nb, while additions of Ti and Mo decreased hot corrosion response.

The study of oxidation and hot corrosion of metal systems revealed a strong concerted effort by the Japanese to provide a higher level of understanding in this area. Because of the direct engineering application in current and future power generation systems, the promotion of these studies has been encouraged by Japan as well as the People's Republic of China. The level of academic and industrial research is highly spurred by the need for improved heat resisting materials in the development of alternative energy power systems.

CONFERENCE ANNOUNCEMENT

The next major conference in the area of metallic corrosion is planned by the 9th International Congress on Metallic Corrosion in Toronto, Canada from 3-7 June 1984. It will be jointly sponsored by the National Research Council of Canada (NRCC) and by the Canadian Region of the National Association of Corrosion Engineers (NACE).

The Congress theme will be the interaction between science and engineering in corrosion research and development. The Technical Program will include the following topics:

- High Temperature Oxidation and Corrosion of Metals and Alloys;
- Passivity, Oxide Breakdown and Localized Corrosion;
- Stress Corrosion Cracking and Hydrogen Embrittlement;
- Corrosion by Mechanical Processes;
- Corrosion in the Chemical, Petrochemical, Power Generation, and Electronics Industries;
- Atmospheric and Marine Corrosion;
- Corrosion in Potable Water and Heating Systems;
- Corrosion Properties of New Alloys;
- Application of New Techniques to the Study of Oxidation Processes;
- New Developments in Corrosion Monitoring and Detection and in Prevention and Control.

Further information can be obtained from:

Lois Baignee, Executive Secretary
9th ICMC
National Research Council of Canada
Ottawa, Ontario, Canada
K1A OR6

Tel: (613) 993-9009. Telex: 053 3145

THE MBE, MAGNETISM, AND OTHER INTERNATIONAL CONFERENCES IN JAPAN

A. Isihara

In the three week period between August 27 and September 14, 1982, International Conferences on Molecular Beam Epitaxy, Magnetism, Neutron Scattering, Transition to a New Type of Ordered Phase, and High Field Magnetism were held in Japan. The last three meetings were more or less related to the Magnetism Conference, although organized independently. The conferences were located at different places: the first one used a Chamber of Commerce building in Tokyo; the second, a resort hotel in Hakone; the third, the Conference Hall in Kyoto; the fourth, the Kansai Seminar House of the Nippon Christian Academy in Kyoto; and the fifth, the University of Osaka. In what follows, in this report, I present only a glimpse of the meetings, as a detailed description is virtually impossible.

MOLECULAR BEAM EPITAXY (MBE) AND CLEAN SURFACE TECHNIQUES (CST) CONFERENCE

The second MBE and CST International Conference was held in Tokyo between August 27 and 30, 1982. It was sponsored by the Japan Society of Applied Physics and by the Surface Science Society of Japan. Professor R. Ueda of the University of Tokyo served as chairman. He was assisted by several co-chairmen including Drs. M. Aoki (University of Tokyo), A. Y. Cho (Bell Laboratories), B. A. Joyce (Philips Research Laboratory), L. L. Chang (IBM Research Laboratory), I. Hayashi (Optoelectronics Laboratory), and by the Program, Local, Organizing and International Advisory Committees. The main topics included:

- doping,
- superlattice,
- quantum well,
- optoelectronic material and devices,
- high-speed and microwave devices,
- growth technology,
- silicon epitaxy,
- II-VI compounds.

With its ability to form smooth ultrathin layers of semiconductors into "superlattices" at desired composition and doping, molecular beam epitaxy provides a very effective and promising fabrication technology, as well as new electronic devices. It yields new families of insulators, magnets, conductors, microwaves, photodetectors, lasers, and other systems. Hence, a new electronics, which may be called molecular electronics, is emerging. In fact, the dimensions of such superlattices is in the range from ten to a few hundred angstroms.

The first MBE Conference was held in Paris in 1978. The rapid growth in MBE technologies and devices since that conference made the present conference very meaningful and successful. The conference attracted some 300 scientists.

A. Y. Cho of Bell Laboratories gave an overview of the exciting field of MBE. In techniques,

- rotating substrate holding has improved uniformity, and
- new beams of As_2 and P_2 have enabled growth of InP and $Ga_xIn_{1-x}As_yP_{1-y}$.

In properties,

- a new family of magnets with Fe on (110) GaAs,
- enhanced mobility in 2D electron systems,
- transitions to semiconductor to semimetals,
- quantized Hall resistance in heterostructures,
- tunability of bandgap and carrier concentration, are among recent studies.

In devices,

- VLSI by silicon MBE,
- new microwave ring oscillators with 60 ps delay time at room temperature,
- new FET's, new high-speed and gain photodetectors, and
- new narrow beam and low threshold laser systems have been developed.

The tunability of bandgap and carrier concentration is to do with the new type of superlattices consisting of alternating n(Si)--and p(Be)--doped layers separated by intrinsic (i-) layers, called "NIPI", which have been developed during the past two years. The unusual properties of the NIPI arise from the well-regulated electron-hole separations which result in a recombination time of around 1,000 sec and a tunable effective energy gap. K. Ploog and G. Dohler of the University of Stuttgart gave reports on new developments. The tunability of conductivity, absorption coefficient, and luminescence makes the NIPI crystals promising for generation, amplification, modulation or detection devices such as avalanche photodetectors.

New polytype superlattices such as GaSb-InAs-AlSb or GaSb-AlSb-GaSb-InAs were described by L. L. Chang of the IBM Research Laboratory. With their variable compositions, wide and interesting possibilities open up. Indeed, they can be semiconducting or semimetallic. Since the potential in AlAs and in the electrodes depends on the layer thickness of AlSb as well as the external voltage, the number and energies of the quantum states at the interfaces can be controlled, and so can the densities of the two-dimensional carriers at the interfaces be varied.

A new double barrier and double heterostructure of GaAs and GaAlAs heterojunction laser with excellent temperature stability and an extremely low threshold current of 250 A/cm^2 was reported by W. T. Tsang of Bell Laboratories.

On the other hand, according to S. Hiyamizu of Fujitsu Laboratory, systematic studies of the dependence of the electron mobility and concentration on structural parameters such as the mole fraction x of AlAs in GaAs/GaAlAs have revealed that the mobility increases with the fraction x and electron density. The latter was found to increase by exposure to light. As a result of these studies, high mobility of around 1×10^6 cm^2/Vs has been achieved.

A. C. Gossard of Bell Laboratories discussed interesting optical and electrical properties of superlattices. For instance, the exciton binding energy increases with decreasing layer thickness in GaAs superlattices, and the optical peaks persist at higher densities and temperatures than in bulk, causing strong nonlinear optical effects. Extensive optical emission studies including laser emission have been conducted recently, and the binding energy of impurity atoms and carriers has been determined. An important aspect of superlattice structures for electrical properties is that dopant impurities can be incorporated into arbitrarily selected layers of the structure, leading to separation of impurities and charge carriers. This results in high mobility and long carrier-scattering time necessary for high-speed devices. In strong magnetic fields, quantized Hall resistance, initially observed in silicon, has now been seen at GaAs/GaAlAs, leading to accurate determination of h/e^2 and to a new resistance standard. When the lowest Landau level is partially filled, new plateaus in Hall resistance and minima in parallel resistance are observed, which indicate electron crystallization.

These new phenomena, observations, and devices stimulate further experimental studies and require much theoretical work. The future of MBE seems to be promising.

INTERNATIONAL CONFERENCE ON NEUTRON SCATTERING OF CONDENSED MATTER

This conference was held at Hakone in the Fuji Hakone National Park between September 1 and 4, 1982. It was the sixth international conference sponsored by the Yamada Science Foundation. Professor S. Hoshino of the Institute for Solid State Physics of the University of Tokyo served as chairman of the Organizing Committee. The conference was planned to mark the twenty years of development of neutron scattering in Japan in conjunction with the Magnetism Conference in Kyoto. It was attended by approximately 150 scientists, including 70 from abroad.

The conference emphasized recent progress on neutron scattering in techniques and topics. Concerning the former, there were reports on:

- polarized neutron,
- pulsed neutron,
- high resolution, and
- spin echo techniques.

Also included was the new synchrotron radiation facility at Brookhaven National Laboratory as summarized by Dr. G. Shirane who compared x-ray scattering with neutron scattering. The synchrotron source is advantageous in providing bright (high Q) radiation and a white spectrum.

There was an evening workshop on polarized neutron techniques in addition to individual contributions. Reports on pulsed neutron techniques were given by Y. Ishikawa (Tohoku University), G. H. Lander (Argonne National Laboratory), J. Eckert (Los Alamos Scientific Laboratory), P. Pacher (Dubna) and others. On the other hand, Dr. F. Mezei pointed out that the spin echo technique started just ten years ago in Budapest as a poor man's venture. Information on facilities in various countries were certainly important to experimentalists.

Neutron scattering has been very useful in the study of condensed matter because in contrast to x-ray, information on both momentum and energy can be obtained. The topics at the conference included:

- magnetic systems,
- solitons, phase transitions and lattice dynamics,
- nonperiodic and nonequilibrium systems, and
- polymers.

At the Magnetism Conference in Kyoto, there were many reports on magnetic systems. Some neutron scattering experiments on magnetic systems will be discussed later in connection with the Magnetism Conference. One-dimensional magnets such as

$(CD_3)_4NMnCl_3$(TMMC), $CsCo_xMg_{1-x}Cl_3$, $CsVCl_3$ with $CsNiCl_3$, $CsFeCl_3$, $CsNiF_3$, etc. and two-dimensional systems such as $Rb_2Co_xNi_{1-x}F_4$ and $(CD_3ND_3)_2CuCl_4$ were among the reports. Competition between ferromagnetism and superconductivity in ternary rare-earth compounds was discussed by H. A. Mook of Oak Ridge National Laboratory.

Phase transitions and solitons attracted much attention. A review of neutron scattering studies of commensurate-incommensurate phase transitions was given by J. D. Axe of Brookhaven National Laboratory. Solitons in magnetic chains were discussed theoretically and experimentally. I discussed an interesting anomaly in the temperature dependence of the structure factor of liquid helium. This anomaly was explained by a theory which gives the structure factor as a function of energy rather than the other way around as in the Feynman relation. I also discussed the anomalous negative energy dispersion of TTF-TCNQ.

Polymer systems can be considered to have a special reduced dimension. Dr. deGennes gave a review talk. One experimental report on the virial coefficient of polymer solutions was interesting because the data indicated that the Flory-type theory needs improvement.

INTERNATIONAL CONFERENCE ON MAGNETISM

This conference was held at the Kyoto International Conference Hall between September 6 and 10. It was a huge conference with over 1,000 scientists attending. With the effort expended by the Organizing Committee, chaired by Professor S. Chikazumi of the University of Tokyo, and of the Program Committee, chaired by Professor K. Yoshida of the Institute of Solid State Physics of the same university, and with the excellent facilities of the huge conference hall, the conference proceeded smoothly. It was reported that the number of attendants increased some 15% over the previous meeting which was held in Munich in 1979.

Historically, Japanese physics has roots in magnetism. The pioneering contributions and subsequent influence of Drs. James A. Ewing, H. Nagaoka, K. Honda, and S. Kaya, were noted at the opening session. The Japanese attendance at the conference was strong with 65% of the attendees being Japanese. The Europeans constituted 15% and the Americans some 9%, in contrast. Professor Yoshida reported that the presentations were classified roughly as follows:

- ferromagnetism in 3D metals,
- rare-earth metal compounds,
- low dimensional systems,
- random systems,
- surface magnetism,
- magnetic order and superconductivity,
- Kondo problem,
- diamagnetism including quantum Hall effect, and
- nuclear magnetism.

Among interesting review talks, J. F. Dillon discussed Faraday rotation, magnetic birefringence and scattering and technological applications. The phase diagram and the temperature dependence of the susceptibility of $Eu_xSr_{1-x}S$ were presented because this material shows huge magneto optical effects and can be ferromagnetic, antiferromagnetic, and insulating.

T. Moriya reviewed work on itinerant ferromagnetism. He began with the familiar Hartree-Fock approximation without evidently knowing of our contribution that the approximation is invalid for electron liquids and that instead of the exchange enhancement, what may be called a correlation enhancement, takes place for $r_s > \sqrt{2}$ in 2D. He pointed out that two quantities,

- the mean square of the local amplitude of spin density, and
- spatial spin correlations (short range order)

are the prime factors for magnetism. When the local amplitude is small and spin fluctuations are not localized, nearly ferromagnetic metals appear. They are:

- Pd, $HfZn_2$, $TiBe_2$, YRh_6B_4, $CeSn_3$, Ni-Pt alloys, etc. As the amplitude increases, weak ferromagnetism is expected, which local moment theory could not explain.

The metals belonging to this category are:

- Sc_3In, $ZrZn_2$, Ni_3Al, $Fe_{0.5}Co_{0.5}Si$, $LaRh_6B_4$, $CeRh_3B_2$, ...

These metals are followed by antiferromagnetic metals:

- β-Mn, V_3Se_4, V_3S_4, V_5Se_8, ...

and then by intermediate cases:

MnSi,	α-Mn	$CeFe_2$
γ-Mn	MnP	CoS_2
Ni	Co,	Fe

The amplitude increases from top to bottom, while spin fluctuations are increasingly localized towards right. Finally, when the amplitude is saturated and the spin fluctuations are localized in real space, magnetic insulator compounds, 4f-metals, Heusler alloys, etc., appear.

The two parameters classify effectively the vast range of magnetic materials. However, it is interesting to observe that the intermediate cases, to which most of the itinerant magnets belong, require further development of theory. For instance, the observed strong short-range order and spin wave-like modes of spin fluctuations above T_C in Ni and Fe should be explained. Consideration of the dynamical aspects of the mutually interacting modes of spin fluctuations in the intermediate cases may help further development of theory. Evidence to favor localization in Ni and Fe will be given later in this report.

There was a session on magnetism and superconductivity. Their interaction has been studied since 1977. M.B. Maple summarized the experimental situation in the following way:

- antiferromagnetism-superconductivity

$REMo_6S_8$	where	RE = CD, Tb, Dy, Er
$REMo_6Se_8$		RE = Gd, Tb, Er
$RERh_6B_8$		RE = Nd, Sm, Tm

- ferromagnetism-superconductivity

  $HoMo_6S_8$
  $ErRh_4B_4$
  $ErRh_{1.1}Sm_{5.6}$

In antiferromagnetic superconductors, the antiferromagnetic order modifies superconducting properties such as the curve of the upper critical magnetic field. In ferromagnetic superconductors, an inhomogeneous state consisting of superconducting regions interspersed with ferromagnetic normal regions apparently occur in a narrow temperature interval above T_{C2}.

S. Sinha reported work on antiferromagnetic superconductors such as $DyMo_6S_8$, $NdRh_4B_4$ and $Ho(Rh_{0.3}Ir_{0.7})_4B_4$, and ferromagnetic single crystals of $ErRh_4B_4$ and $HoMo_6S_8$. Neutron scattering reveals ferromagnetic Bragg peaks, in addition to the satellite peaks of the spin-sinusoidal order, in a narrow temperature range. Based on the strength of the Bragg peaks, the coexistence of the two competing orders is concluded.

Theoretically, magnetism may be carried by the f electrons of the rare-earth ions and superconductivity by the d electrons of the transition metals. Although the two orders are exhibited by the electrons in different ions, the coherence length of superconductivity is larger than the lattice constant of the rare-earth ions so that one can talk about the coexistence.

There were several sessions on low dimensional systems indicating strong interest. A review on one-dimensional organic superconductors was given by D. Jerome. The material includes, $(TMTSF)_2X$ with X = PF_6, AsF_6 (octahedral) and X = Cl_4, ReO_4 (tetrahedral). The work has mostly been carried out at Copenhagen and at Orsay. In the case of $(TMTSF)_2$ ReO_4, (tetrahedral) the conductivity in the a direction is around 500-600 $(\Omega cm)^{-1}$, while in the b direction, 50-360 $(\Omega cm)^{-1}$ and in the c direction of order 1 at 300° K. The high conductivity in the a direction is due to the overlapping of the π orbitals.

There were many other sessions which deserve reporting. Nevertheless, I comment only that topics such as disordered state and magneto optics exhibited an increase in the number of presentations, and also there was one interesting review talk on earth magnetism.

INTERNATIONAL MEETING ON TRANSITION TO A "NEW TYPE OF ORDERED PHASE"

This meeting was organized as a satellite conference to the Magnetism Conference. The chairman of the Organizing Committee was Professor T. Haseda of Osaka University. It was sponsored by the Nishina Memorial Foundation, the Yamada Science Foundation, and the Yoshida Foundation for Science and Technology and was supported by the Physical Society of Japan with regard to publication. It was held at the Kansai Seminar House in Kyoto between September 11 and 13 and was attended by approximately 110 scientists.

The topics at this conference included:

- two-dimensional systems,
- various types of transitions,
- spin glasses,
- percolation, fractals, nonequilibrium systems, and
- triangular lattices.

Some papers of this conference overlapped with those of the Magnetism Conference, as Dr. Haseda mentioned with a tone of lament. For instance, out of nine talks on two-dimensional systems on the opening day, six or seven were on the XY and other magnetic systems.

Ressat-Mignod presented a talk on $BaM_2(XO_4)_2$ where (M = Co, Ni, X = P, As) as a good realization of the 2D XY system. He reported on the same system at the Magnetism Conference also. In these layered compounds, the hydrodynamic spin waves are strongly damped and disappear before T_N, while the short wavelength spin waves persist above T_N with important renormalization effect, suggesting the existence of a Kosterlitz-Thouless-type phase transition.

M.E. Fisher discussed the melting of two-dimensional commensurate systems such as H on Fe (100) or Kr on graphite and suggested the existence of new universality classes of commensurate melting transitions due to heterodomain fluctuations.

H. Ikeda discussed neutron scattering results on the time evolution of an interplanar order in a layered Ising antiferromagnet, $Rb_2Co_xMg_{1-x}F_4$ during quenching to a low temperature state from a disordered high temperature state. The scattered intensity at the (100) antiferromagnetic Bragg position increased with time at the early stage but varied as ln t at a later stage. He tried to relate this result with Kawasaki's recent theory, but only inconclusively. K. Kawasaki presented a new dynamical theory for random interfaces which are formed shortly after quenching.

I discussed a microscopic theory of a valley occupancy phase transition in silicon inversion layers based on our new all density theory of two-dimensional electron systems. The theory gave a transition point in agreement with what was observed at the Naval Research Laboratory recently. This type of phase transition was apparently a "new type" to many attendants, as some of them commented to me later.

There were several talks on fractal dimensions. Crossover of such dimensionality may be considered to represent a transition. Concerning spin glasses, J.A. Mydosh described the temperature, field, and concentration dependences of the susceptibility above the freezing temperature of a spin glass based on a cluster model and also ESR data below the freezing temperature. The long-range model of Sherrington and Kirkpatrick was examined for the case with a magnetic field by Sherrington and others. A magnetic field breaks the symmetry of an isotropic spin glass in an interesting behavior. M.A. Moor applied the same model to metastable states in Ising and vector spin glasses and evaluated the total number of metastable states. K. Binder treated the spin glass model with short-range interactions, and emphasized the dynamical, rather than equilibrium, nature of the freezing transition. There were many other papers on the subject, including numerical simulations and applications.

In triangular antiferromagnets such as $CsNiFeF_6$, frustration effects are expected. M. Steiner reported on neutron scattering data. T. Oguchi explained the lack of the resonating valence bond state based on spin wave theory.

INTERNATIONAL SYMPOSIUM ON HIGH FIELD MAGNETISM

This was another satellite conference to the Magnetism Conference. It was held at Osaka University between September 13 and 14. Professor M. Date was the chairman. It was sponsored by the Japan Society for the Promotion of Science and the Yamada Science Foundation. Approximately 150 scientists attended this conference. The subjects included:

- introduction to high field magnetism,
- magnetic interactions,
- metals and alloys under high magnet fields
- high field transport,
- technical problems,
- high field magnetic resonance, and
- amorphous magnetism.

Due to a one day overlap with the New Type of Ordered Phase Conference, and my busy schedule, I was able to attend the conference only partially. Nevertheless, I felt the uniqueness and importance of this meeting. The list of worldwide high field facilities displayed at the conference was interesting even to theorists like myself.

The Francis Bitter National Magnet Laboratory, at the Massachusetts Institute of Technology, is the largest facility in the world for the generation of intense continuous fields up to 30 T in 3.3 cm bore and a homogeneous 25 T in 5.4 cm bore. At the Service National des Champs Intenses in Grenoble, France, 15-20 T in 5 cm bore and 14 T in 22 cm bore are produced. A new facility there includes 30 T at 5 cm bore. At the Kurchatov Institute of Atomic Energy in Moscow, pulsed fields of 50 T in 15-20 mm bore can be produced for 15 msec. At Tohoku University, pulsed magnetic fields up to 27.3 T are produced and a new 16.5 T superconducting magnet is installed. At Osaka University, three pulsed magnet systems are being used: 70 T for 0.4 msec in 2 cm bore, 50 T for 0.35 msec in 5 cm bore and 50 T for 0.3 msec in 3.4 cm bore. At Tokyo University, 2.8 MG and 3.7 T pulsed field (for 2ms) can be generated.

M. Date reported that in intercalation compounds C_6Eu, a weak four-spin exchange interaction exists in addition to the usual two-spin exchanges. Other reports on what came from the Osaka facilities included:

- coexistence of the dense Kondo state with the antisotropic f-f exchange interaction,

- clear enhancement due to magnetic impurities of the upper critical magnetic field in $Pb_{0.7}Eu_{0.5}Mo_6S_8$,

- conservation of the total nodal surface number as a good quantum number in addition to parity and magnetic quantum number, as observed in the Z-excitation in InSe as a hydrogen-like system.

There were several reports on H_{C_2} by some other groups.

F. Pauthenet reported deHaas-van Alphen oscillations in nickel and iron and absence of a T^2 term in the temperature dependence of the spontaneous magnetization, favoring the localization theory. Concerning dHvA oscillations, I reported peculiar behavior of surface electrons which is caused by the discontinuous changes of the Fermi energy. I concluded my talk by mentioning that it took some twenty years since the discovery of the effect, until the first ideal gas theories of the dHvA effect were given by Lifshitz and Kosevich and by Onsager and that we do not want to wait twenty more years to have our theoretical predictions tested by experiment. There was a valid question concerning the effect of crystallization. My response was that the dHvA effect comes from the orbital motion of the electrons.

INTERNATIONAL SYMPOSIUM ON THE PROPERTIES AND APPLICATIONS OF METAL HYDRIDES II

D. A. Papaconstantopoulos

INTRODUCTION

The International Symposium on the Properties and Applications of Metal Hydrides II was held 30 May-4 June 1982 at Toba, Japan. There were sessions on crystal structures, phase relations, and physical properties of metal hydrides, as well as electronic structure calculations, applications, and engineering aspects. The following is a summary of the technical program as presented by some of the participants.

TECHNICAL PROGRAM

A. F. Andersen of the Institute for Energy Technology (Norway) presented neutron diffraction studies in metal hydrides. He presented evidence of the structural changes observed when hydrogen is absorbed in a metal. He gave examples for a great variety of hydride systems ranging from Laves phase alloys to FeTi and $LaNi_5$.

M. H. Lee of the University of Georgia (U.S.A.) reformulated a previous model by Takagi to study cluster formation and isotope separating ordered and disordered phases that terminates in a tricritical point; and a second order transition with mean-field-like critical properties.

H. Metzger of the University of Munich (West Germany) studied the trapping behavior of H in Nb single crystals. He concluded that the distortion due to H is about 30% smaller than the one due to untrapped H.

D. G. Westlake of the Argonne National Laboratory (U.S.A.) presented a model based on geometric considerations that predicts the sites occupied by H or D in a variety of intermetallic alloys. In the case of ZrNiH, he gave a confirmation of his model by comparing it to neutron diffraction measurements.

A. Percheron-Guegan, of the Centre National de la Recherche Scientifique (C.N.R.S.), (France) discussed experiments on hydrogen mobility in $LaNi_5$ and also in substitutional alloys when Ni is replaced by Mn or Al.

T. Kajitani of the Tohoku University (Japan) studied the stability of the β-phase of V-Cr-D and V-Ta-D alloys by means of x-ray, neutron diffraction, and heat capacity measurements. He concluded that the occupation probability of deuterium atoms in the tetrahedral sites increases by the additions of Cr or Ta.

H. Uchida of Tokyo University (Japan) investigated the influence of rare-earth metals on hydrogen absorption in $LaNi_5$ alloys. He showed that the replacement of La by Ce or Sm has brought higher hydrogen equilibrium pressure.

A. Yoshikawa of the National Institute for Metals, (Japan) presented experimental studies of pressure-composition isotherms of AB_5 hydrides. He gave a correlation between the volume contraction during compound formation and the stability of intermediate hydride phases.

S. Ono of the National Chemical Laboratory for Industry (Japan) examined x-ray powder patterns of Mg_2NiH_4 and from the observed extinctions concluded that it has the body-centered symmetry.

W. E. Wallace of the University of Pittsburgh (U.S.A.) presented a review covering thermodynamic properties, surface, structural characteristics, and electronic structure of hydrogen absorbing intermetallic compounds.

T. Okamoto of the University of Hiroshima (Japan) discussed the effects of absorbed hydrogen on the magnetic properties of $Y(Fe_{1-x}Mn_x)_2$ compounds. His main conclusion is that the magnetic moment of the hydride is larger than that of the host compound.

E. P. G. Ponyatovsky of the Institute of Solid State Physics of the U.S.S.R. Academy of Sciences presented results of his studies of phase transformations of metal hydrides at high pressures.

M. Gupta of the University of Paris (France) reviewed band structure calculations of intermetallic transition metal hydrides with emphasis on the hydrogen storage materials TiFeH and $TiFeH_2$. Her results show that metal-hydrogen states appear at 9eV below the Fermi level and that the Fermi energy, E_F, of the hydrides shifts to higher energies thus increasing the value of the density of states at E_F over its value for pure TiFe. One important conclusion of Gupta's work is also that the H-H interaction controls the stability of this hydride.

Further calculations of the electronic structure of $TiFeH_x$ were presented by D. A. Papaconstantopoulos, of the Naval Research Laboratory (U.S.A.). He discussed an application of the coherent-potential-approximation to study disordered $TiFeH_x$ alloys which occur when vacancies are created in the H sublattice. His results argue for nonrigid band behavior of the metal-hydrogen bonding levels with hydrogen mainly bonding to Fe. He suggests a charge transfer for H sites to the metal sites and approximately rigid band picture of the d-states near the Fermi level.

B. M. Klein of the Naval Research Laboratory (U.S.A.) in another theoretical paper discussed an investigation of the hydrogen storage behavior in Laves phase compounds. He used a muffin-tin Green's function approach for treating the effects of the H impurities in the dilute limit. By examining the host and local impurity charge and state densities he identifies the variations of hydrogen bonding and stability of these compounds.

A. C. Switendick of Sandia Laboratories (U.S.A.) presented the electronic energy bands of α and β phase UH_3. These systems are unique among hydrides due to the formation of trihydride phase without an intervening dihydride phase. He has found strong bonding interaction between the U f-electrons and H s-electron. He has identified two types of f-character: localized and itinerant. The itinerant type is as large as one electron per U atom with the greater contribution coming from the linear chain atoms that form three of the four H neighbours.

W. G. Baumann of the University of Tubinger (West Germany) talked about the electronic and elastic structure of hydrogen in metals. He discussed a scheme which decouples the problem of a hydrogen atom in a metal into separate equations for the electron, the proton, and the metal ions.

A. Fujimori of the National Institute for Research in Inorganic Materials, (Japan) presented calculations of the electronic structure of nonstoichiometric titanium hydride. He argues that the Fermi level does not shift with respect to the d-bands for different H concentrations. He also seems to confirm that the tetragonal distortion of TiH_x with $1.8 < x < 2.0$ is due to a Jahn-Teller effect.

G. Bambakidis of the Wright State University (U.S.A.) presented the electronic structure of vanadium-hydrogen clusters using a self-consistent multiple scattering method. He addressed the question of an instability arising from the existence of a two-fold degenerate electronic state.

D. Richter of the Institut fur Festkorperforschung (West Germany) reviewed recent experimental results on the local vibration of H in selected refractory metals. These measurements revealed detailed microscopic information on the symmetry of the trapping sites, their degree of disturbance, and the temperature dependence of site occupation.

G. Sicking of the Institut fur Physikalische Chemie (West Germany) spoke on the hydrogen isotope exchange and separation in gas-solid phase systems. O. Al-Erhayem of the Helsingor Teknikum (Denmark) discussed the determination of hydrogen and the dissociation of hydrides in weld-metal. M. Amano of the National Research Institute of Metals (Japan) presented a study of the hydrogen storage properties of $FeTi_{1-x}$ and $FeTi_{1-x}O_y$ flakes produced by a splat-quenching method. J. Töpler of Daimler-Benz Laboratories (West Germany) gave a very interesting paper on the development of hydrides for motor vehicles. He discussed operational possibilities for low and high temperature hydrides and progress on technical problems. One of the systems used is $TiV_{0.6}Fe_{1.5}Mn_{1.5}$-H. J. J. Reilly of Brookhaven National Laboratory (U.S.A.) reported on irreversible effects in the FeTiH system. A practical consequence of one of these effects is the distortion of the pressure-compositions isotherm in the β- region as a function of hydriding-dehydriding cycles.

There were also papers on heat transmissions and heat exchange designs and other engineering applications. A lecture by Y. Igarashi of the Agency of Industrial Science and Technology (Japan) dealt with the "Sunshine Project." This project is a well-funded effort of the Japanese to explore energy sources including solar energy, geothermal, coal, and hydrogen as a fuel. In the area of solar energy, emphasis is given on basic research covering the electronic properties of both crystalline and amorphous semiconductors.

A. J. Maeland and G. G. Libowitz of Allied Corporation (U.S.A.) presented investigations of hydrogen absorption in new hydride systems. Their study included beryllium-based intermetallics, and oxygen stabilized intermetallic phases such as Ti_2NiO_x and $Zr_6Pd_3O_x$. They also discussed hydrides of metallic glasses and compared them with the corresponding crystalline intermetallic compounds.

If further information regarding the conference or the publication of the proceedings is desired, please contact:

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THE RISE OF THE JAPANESE COMPUTER INDUSTRY

George E. Lindamood

INTRODUCTION

In the past twenty years, the Japanese have come from virtual obscurity to challenge the United States for world leadership in computers, telecommunications, and semiconductors. Japan now has more than half as many computers as the U.S., and their growth rate is double that of the U.S. There is growing concern that Japan's progress will adversely affect the U.S. computer and semiconductor industries, repeating what has already happened in textiles, shipbuilding, steel, automobiles, optical products, and consumer electronics. This concern is heightened by perceptions of the role computers, telecommunications, and electronics will play in future societies, so-called "postindustrial" societies based primarily upon the control and use of information.

In order to gain a better understanding of the Japanese computer industry at present, it is necessary to know something of the background of the principal participants. This paper endeavors to present this information in fairly succinct form: first, with brief descriptions of the various governmental agencies, companies, and universities which have played a significant role in the development of the Japanese computer industry; second, with a chronology of the various Japanese legislative and administrative measures pertaining to computers, to describe the environment which the Japanese have sought to create; and third, with a chronology of various computer-related research projects. The paper concludes with the author's personal assessment of the present situation and projection of future trends.

THE PARTICIPANTS

- The Japanese Government

More than any other part of the Japanese government, the Ministry of International Trade and Industry (MITI) has been responsible for Japan's rise to preeminence in computers and electronics. Put very simply, the mission of MITI is to develop and administer Japanese industrial policy. This it does through a myriad of bureaus and agencies, the most important (to computer technology) of which are:

- the Machinery and Information Industries Bureau, and
- the Agency of Industrial Science and Technology.

The Machinery and Information Industries Bureau is the latest incarnation of what was once called the "Heavy Industries Bureau" of MITI. Within it, three divisions are concerned with computer-related matters:

- the Electronics Policy Division,
- the Industrial Electronics Division, and
- the Data Processing Promotion Division.

The relationship of the Agency of Industrial Science and Technology (AIST) to Japanese industry appears to be somewhat the same as that of the National Science Foundation to universities in the United States. It is responsible for administering various large-scale projects which are under a National Research and Development Program. Notable among the organizations under AIST is the Electrotechnical Laboratory (ETL), now located in the new Tsukuba "Science City." ETL is the largest national research institute in Japan for electronics and information processing and, as such, has been involved in some way in nearly all computer-related projects sponsored by MITI.

The Ministry of Posts and Telecommunications (MPT) has had a growing impact on Japan's computer industry, largely because of the increasing intermingling of computer and telecommunications technology throughout the world. In many respects, MPT's influence in Japan has been a negative one in protecting entrenched telecommunication interests from being too rapidly overtaken by changing technology. This has occasionally led to internal battles with MITI over policy and even "turf."

Mention must also be made of the Ministry of Finance (MOF) because of its key role in the budget process within the Japanese government: MOF decides what programs in the various ministries will be funded for how long and at what level. In that sense, it is equivalent to the Office of Management and Budget (OMB) in the U.S. government, but it also has Treasury Department-like powers in influencing tax policies, interest rates, etc.

There are also three quasi-governmental organizations of relevance to the Japanese computer industry:

- the Japan Electronic Computer Company,
- the Japan Information Processing Development Center, and
- the Information-technology Promotion Agency.

The Japan Electronic Computer Company (JECC) was established in 1961 by the "big six" computer manufacturers (plus Matsushita Electric Industrial Company, which later dropped out when it quit the computer business in 1966) with strong financial backing from the Japan Development Bank. The primary role of JECC has been to act as a "third party leasing firm" so that Japanese computer makers are spared the cash flow problems of leasing their systems to Japanese users.

The Japan Information Processing Development Center (JIPDEC) was established in 1967 with the support of MITI, MPT, and industry organizations to develop information systems for both government and industry. Perhaps its most visible activities have been conducting surveys and studies of the information processing industry within Japan and throughout the world and publishing the findings (in English as well as Japanese) in quarterly *JIPDEC Reports* and annual *Computer White Papers*. In April 1976, JIPDEC absorbed two similar MITI-managed organizations, the Japan Computer Usage Development Institute (JCUDI) and the Japan Institute of Information Technology.

The Information-technology Promotion Agency (IPA) was established in October 1970, "for the purpose of promoting software development and utilization, and advancing the information processing service industry in Japan." The principal activities of IPA have been to support certain basic research in software engineering (the exact nature of which has been virtually impossible to discern) and to provide loan guarantees for Japanese software companies and service bureaus.

- The Companies

Six companies dominate the computer business in Japan: Fujitsu Ltd., Hitachi Engineering Company, Nippon Electric Company (NEC), Mitsubishi Electric Corporation, Toshiba Ltd., and Oki Electric Industry Company. Four of these--Fujitsu, Hitachi, NEC, and Toshiba--are major manufacturers of semiconductors; four--Fujitsu, Hitachi, NEC, and Oki--are also major suppliers of telecommunications equipment; three--Hitachi, Mitsubishi, and Toshiba--are major manufacturers of heavy industrial equipment; and four--Hitachi, NEC, Mitsubishi, and Toshiba--also make consumer electrical and electronic products. In addition, several other major producers of electronic equipment, including Matsushita Electric Industrial Company, Sharp Corporation, Sony Corporation, Casio Corporation, and Canon Corporation, are also actively engaged in the manufacture and sale of small computers.

Fujitsu Ltd., is the Japanese standard-bearer computers. It made the earliest and most major commitment to computers among Japanese manufacturers and has always participated in the major computer projects sponsored by the Japanese government. Fujitsu built Japan's first digital relay computer (in 1935) and was the first to market a commercial machine, the FACOM 100 (announced in October 1954).

In December 1972, Fujitsu reached an agreement concerning technical information exchange with Amdahl Corporation and acquired a 24% equity in Amdahl for $6.2 million. In August 1974, it was announced that Amdahl's 470V/6 computer would be produced in Japan by Fujitsu and exported to the U.S. and elsewhere. The first system was shipped December 1974, and was installed in a NASA laboratory in New York City in June 1975.

Other Fujitsu cooperative activities worldwide include:

- Panafacom, Ltd., formed June 1973, with Matsushita to develop and manufacture mini and microcomputers;

- Fujitsu Espana S.A., formed June 1973, with the Credit Bank of Spain to import computers and communications equipment from Japan for local marketing;

- Nippon Peripherals, Ltd., (NPL), formed September 1973, with Hitachi to develop, manufacture, and market peripherals (especially, disk drives) and terminals--NPL subsequently (in 1976) entered into joint agreements with Memorex in the U.S. and BASF in West Germany;

- an agreement, signed July 1976, with the Canadian government to collaborate with Consolidated Computers, Inc., (CCI) of Ontario in the production and sales of computers, peripherals, and terminals (and under which Fujitsu acquired 20% equity in CCI);

- an original equipment manufacture (OEM) agreement with Siemens in July 1978, covering the M-200 and M-180II-AD computers and the OSIV/F4 operating system; and

- a joint venture with TRW established in 1979 to market Fujitsu's point-of-sale systems and small computers. In 1979, Fujitsu's data processing revenues exceeded those of IBM Japan for the first time. Fujitsu is now ranked sixth in the world, ahead of Honeywell (U.S.), CII-Honeywell Bull (France), ICL (U.K.), and Siemens (West Germany).

Hitachi Ltd., is Japan's third largest company (after Nippon Steel Corporation and Toyota Ltd.). It entered the computer market in the late 1950s and was one of the first Japanese companies to enter into a technology exchange agreement with a U.S. computer maker: RCA in 1961.

Hitachi was first approached by Amdahl regarding a cooperative venture in the early 1970s but turned down the offer (after which Amdahl went to Fujitsu). Around 1975, Hitachi held exploratory discussions with Control Data Corporation (CDC) regarding the possibility of Hitachi systems in the U.S. and the installation of M-180's in CDC's computer service bureaus. In March 1976, Hitachi announced an agreement with Itel to provide AS/6 central processing units (CPU) (based upon the M-180) on an OEM basis; this agreement was extended to include the AS/7 (based upon the M-200H) in November 1978, and the AS/8 (based upon the M-280H) with Itel's successor, NASCO, in 1979. During the 1978-80 period, Hitachi also completed marketing arrangements for its computer systems in Europe with BASF (West Germany), Olivetti (Italy), and St. Gobain (France).

Nippon Electric Co., Ltd. (NEC), established in 1899 as a joint venture of Western Electric and a Japanese trading company, has been Japan's largest manufacturer of communications equipment. In addition to being the world's largest producer of satellite communications, earth stations, and microwave communications systems, NEC produces and markets over 14,000 products in some 100 countries worldwide.

NEC announced what it called the world's first transistorized computer at the Paris World Exposition in June 1959. NEC entered into a technical exchange agreement with Honeywell in 1962; that agreement lapsed in 1978 when NEC opted not to renew it. NEC was by far Japan's leading computer manufacturer until 1965, after which it was surpassed by Fujitsu and Hitachi because it chose to emphasize the communications side of its business. In 1981, however, NEC once again passed Hitachi in computer sales and assumed the number two spot in Japan. Worldwide, NEC is ranked either just above or just below Motorola (depending upon the yen exchange rate) as the number two supplier of semiconductors. In April 1977, NEC established a wholly-owned subsidiary, NEC Information Systems, in Lexington, Massachusetts, to market office computers, intelligent terminals, printers, and disk drives.

Mitsubishi Electric Corporation was the last of the Japanese "big six" to enter the computer field. In the early 1960s, it produced and marketed versions of various American machines under licensing agreements with Bendix, TRW, and Westinghouse. When TRW withdrew from the data processing business in 1970, Mitsubishi entered into a technical exchange agreement with Xerox Data Systems. In December 1977, Mitsubishi announced the establishment of MELCOM Business Systems in Los Angeles to market the MELCOM 80 series of small computers in southwestern United States.

Toshiba Ltd., was an early collaborator with Tokyo University in the development of a tube computer (installed May 1954). After unsuccessful negotiations for technical affiliation with Univac, Toshiba entered the commercial market in December 1961. An early series of machines, the TOSBAC 3400, was developed jointly with Kyoto University. Subsequently, under a technical agreement (reached in 1964) with General Electric (GE), it produced and marketed the TOSBAC 5400 and 5600 series based on the GE 400 and 600 series, respectively.

Paired with NEC in the joint computer development efforts instigated by MITI in the 1970s, Toshiba began pulling back from activities in large and medium-scale computers in 1978 and concentrated its efforts in office computers (which it introduced in 1977) and minicomputers.

Oki Electric Industry Corporation was one of Japan's first entrants into the computer market with its self-developed, transistorized OKITAC 6020 in 1959. Oki-Univac Company Ltd., was formed in September 1963, with 51% Oki ownership to manufacture various

Univac-based machines in Japan. Since that time, Oki has not engaged in the development of large computers; rather it has been forced (because of financial difficulties) to pull back from computer development since the oil crisis of 1973. However, it remains strong in peripherals and terminals. It established subsidiaries in the U.S. to produce and market communications equipment (in 1972) and computer peripherals, terminals, and components (in 1973), and has subsequently set up similar operations in Germany and Brazil.

Nippon Telegraph and Telephone Public Corporation (NTT) is not a private company like those described above (although it endeavors to operate much like one); its stock is owned by the Japanese government. It receives administrative guidance from MPT; and its budget, services, tariffs, and overall policies, as well as appointments of its top officials, are subject to governmental review and approval.

It is the second largest telephone company in the world, although it has no captive supplier (like AT&T's Western Electric). It spends about 2% of its revenue for R&D (which amounted to more than $350 million in 1980), mainly at its three Electrical Communications Laboratories at Musashino, Yokosuka, and Ibaraki. It licenses the technology it develops to the Japanese manufacturers--primarily NEC, Fujitsu, Oki, and Hitachi--who build equipment to its specifications. These licenses are generally of a nonexclusive nature, which means that the companies are then free to use the same technology in their commercial products.

NTT also serves as the project manager for various national projects which serve social needs. Currently, there are seven such NTT-operated systems, including vehicle registration, meteorological data acquisition, air route radar information, and employment insurance.

Kokusai Denshin Denwa, Ltd. (KDD), operates Japan's international telephone, telegraph, and related communications services. Split off from NTT in 1953, it is 90% privately owned, with 10% of the stock being held by NTT.

- The Universities

Among the various national universities in Japan, the "big seven" are the Universities of Tokyo, Kyoto, Osaka, Tohoku, Hokkaido, Nagoya, and Kyushu. Of these, Tokyo University (Todai) is the most prestigious, having been characterized as "Harvard, Yale, and Princeton all rolled into one." In computers, Todai has activities in several departments: Information Science (in the Faculty of Science), Information Engineering (in the Faculty of Engineering), Precision Engineering, etc., as well as a mammoth central Computer Center. In most other universities, there is just one department (usually in the Faculty of Engineering), plus a (sizeable) central Computer Center. Kyoto University claims to have the oldest such department, which (therefore) may rival those of Todai in prestige.

Other national universities which have significant computer science departments include Tsukuba University and the Tokyo Institute of Technology. Among private institutions, only Keio University and Waseda University appear to have computer science programs worthy of note.

THE ENVIRONMENT

The following is a brief summary of the various legislative and administrative measures which have been used by the Japanese government to promote development of

The Council--which was renamed the Electronic and Machinery Industries Deliberation Council in 1971--is a classic example of the Japanese mechanism for obtaining consensus. Its membership, numbering about forty, includes key industry and government officials and distinguished scholars. Problems, research topics, and policy proposals are brought before the group by the EIS, and after consensus is reached, the Council position is announced as a formal guideline to MITI policy. Differences of opinion are resolved outside the meetings of the Council itself, so that confrontations are avoided. (In practice, consensus has rarely been hard to achieve; the computer policy positions of the EIS have usually been ratified by the Council.)

The financial assistance has usually been quite modest: just enough to "lubricate the consensus process" and to stimulate investment in accordance with MITI's plans to rationalize production, that is, specialize the production mix within various companies.

- Foreign Imports and Investment

Several Japanese companies began commercial production of computers in 1958 and 1959. The IBM Corporation and Sperry Rand (now Univac) also wished to establish manufacturing operations in Japan, but the Japanese were concerned about protecting their infant industry. Under the Japanese Foreign Investment Law of 1951, government authorization was required for foreign manufacturing activities, and in nonliberalized industries that authorization was granted only if doing so would also serve some domestic Japanese interest.

In the case of computers, that domestic interest was gaining access to basic computer patents held by IBM and (to a lesser extent) Sperry Rand, so after extremely long negotiations, IBM was given foreign exchange remittance guarantees and permitted to establish a wholly-owned manufacturing subsidiary in Japan in 1960. In return, all interested Japanese manufacturers were given access to IBM's basic patents under a royalty agreement subject to periodic renegotiation. In 1963, Sperry Rand entered into a joint venture company, Oki-Univac, with Oki Electric Industry Company. Oki's interest was set at 51%, thereby allowing the firm's computers to be classified as "domestically produced" in Japan, an important distinction which IBM and NCR did not enjoy. (NCR held 70% equity in a manufacturing subsidiary established in Japan in the late 1930s.)

To obtain foreign computer know-how, Japanese manufacturers were encouraged to enter into technical assistance and cross-licensing agreements with American firms. Hitachi signed such an agreement with RCA in 1961; Mitsubishi signed with TRW and NEC with Honeywell in 1962; and Toshiba signed with GE in 1964.

U.S.-made computer imports into Japan were also considerable during that period; in 1961, amounting to 70% of the domestic market. To protect the indigenous computer industry, the Japanese government raised tariffs on computer imports from 15% to 25%. A number of nontariff barriers were also instituted to encourage customers to "buy Japanese," and JECC was established to assist Japanese computer manufacturers in lease financing.

- The Awakening

On April 7, 1964, IBM announced the IBM Series 360, heralded as the "third generation" of computer systems. The effect on the Japanese was profound. Faced with the prospect of a widening technology gap, the Keidanren--Federation of Economic Organizations--and the ruling Liberal Democratic Party (LDP) developed for the first time a knowledgability of, and serious policy interest in, computers. Industry-government computer policy interactions intensified, with MITI at the center. There was a "gradual realization that computers would in the future have a dramatic if not revolutionary impact on the conduct of all business." This was "the dawn of Japan's computer mentality."

Realizing that Japanese computer technology development must be accelerated (especially in software), that the small-scale and fragmentation of the domestic industry must be eliminated, and that the potential impact of computers on business must be understood, MITI called upon the Electronics Industry Deliberation Council to develop an industry strategy. The resulting Council report, in 1966, has been characterized as "the most important document in the industry's history." After first confirming the computer industry as most important to Japan's future, it set the following objectives:

- technological excellence independent of any foreign interest,
- increased Japanese share of the domestic computer market, and
- increased profits by domestic manufacturers.

To meet these objectives, the Council recommended several programs which were subsequently implemented:

- strengthening JECC,
- initiating a new large-scale computer development project (in 1966-71),
- establishing a peripheral equipment cartel (in 1969) to produce punched card and paper tape devices, and
- establishing JIPDEC (in 1967) to improve the training of systems analysts.

In 1967, an Information Industry Subcommittee was established within the Industrial Structure Deliberation Council, "one of the most powerful advisory and executive groups within MITI." At the same time, the Keidanren set up a Committee on Data Processing to explore issues and recommend policy to the government, and some 160 LDP members of the Japanese parliament formed the Diet Members Federation for Promotion of the Information Industry to explore policy questions and develop recommendations for the LDP leadership. While both of the latter groups carried out several studies and submitted extensive recommendations, MITI (in 1969) directed the Information Industry Subcommittee to prepare a major report delineating objectives and programs.

- The IPA Law of 1970

The (aforementioned) Subcommittee's report focused on three areas: software development, personnel training, and time sharing. Its recommendations were subseqently embodied in a 1970 law which created the Information-technology Promotion Agency (IPA). (The activities of IPA have been described above.) An Information Technology Institute was also established under the Ministry of Education to train programmers, also as recommended by the Subcommittee.

In the area of time sharing, a considerable wrangle developed between MITI and MPT, and ultimately the Keidanren Committee and the Diet Federation were enlisted to help marshall the forces to overcome MPT's reluctance to allow time sharing outside NTT. Another law, passed by the Diet in 1972, resulted from the eventual compromise; it provided for some liberalization of the use of telephone circuits for data communications, although restrictions on networking were allowed to remain. These have somewhat hampered the growth of Japanese computer companies in a very important technical area and are (at this writing) being hotly debated in current Diet deliberations aimed at further liberalization.

- The 1971 Law

In response to a MITI request to recommend a new industrial policy for the 1970s, the Industrial Structure Deliberation Council published, in May 1971, a report recommending that industries which contribute to overcrowding and pollution be phased out in Japan and that they be succeeded by a "knowledge-intensive industrial structure" comprised of semiconductors, computers, robots, office and communications machinery, high fashion (including furniture), and management services such as systems engineering, software, and industrial consulting.

A specific outgrowth of this report was the passage, in 1971, of a "Law for Extraordinary Measures for Specific Electronic and Machinery Industries" (Kidenho). Basically, this law superseded and updated the 1957 law (described above). Under this law, a new Machinery and Information Industries Bureau was created within MITI to oversee electronics, computers, automobiles, and general machinery. This law also provided the authority under which MITI sought to partially restructure the Japanese computer industry through the "3.75 generation" computer development effort. (See below.)

- The 1978 Law

When the Kidenho expired in 1978, it was succeeded by a "Law for Extraordinary Measures for Specific Machinery and Information Industries" (Kijoho). The change of wording in the title, from "Electronic" to "Information", was regarded as indicative that the future emphasis in the development of the Japanese computer industry would extend beyond just hardware. Specifically, the law provides for increased support of independent software firms (through IPA) and changes in accounting procedures to generate tax benefits which will help the software industry. In addition, the law also calls for the formation of a joint development organization to incorporate VLSI technology and basic software into the next computer generation. This has been manifested in the Fifth Generation Computer System project (described below)

COMPUTER-RELATED RESEARCH PROJECTS

The following is a list, with brief summaries, of the various computer-related research projects which have been sponsored by the Japanese government.

- Early ETL Computers

In the early and mid-1950s, the Electrotechnical Laboratory built several experimental computers, often with the assistance of some of the companies mentioned above. The Mark I (completed December 1952) and the Mark II (completed November 1955) were both relay machines, the latter having binary floating-point arithmetic capability. The Mark III (completed July 1956) used point contact transistors, which proved to be rather unreliable. The Mark IV (completed November 1957) used junction-type transistors and led to commercial computer products announced by NEC, Fujitsu, Hitachi, and Toshiba in 1958-59 and by Oki, Matsushita, and Mitsubishi in 1961.

- The Todai Automatic Computer (TAC)

Beginning in 1952, the Ministry of Education funded the development of a vacuum tube computer at Tokyo University (with Toshiba assistance). It was installed in May 1954, but the machine was not completed until sometime in 1959.

- The FONTAC Project

In 1962, MITI suggested that the Japanese manufacturers pool their resources in a project to develop a large computer, an area of technology where Japan was particularly weak at the time. Three companies responded, and the FONTAC project was established under AIST sponsorship. Fujitsu developed the software, and Oki and NEC developed the hardware.

The project, which lasted three years, was "reasonably successful." What was more important was that the project established a technique for MITI management of the industry. The know-how resulting from the project was the exclusive property of the participating companies, which gave them considerable competitive advantage in developing subsequent commercial products; for instance, Fujitsu's FACOM 230-50 computer was a direct result of this project. Of lesser (albeit still significant) value was government funding support and useful collegial ties between government officials and industry executives.

- The Super High-Performance Computer Project

The announcement of the third generation IBM 360 series in 1964 spurred MITI to respond with another project aimed at developing a large-scale computer. Again the project was sponsored by AIST, with some $35 million in funding over the 1966-71 period. MITI chose the three leading and most viable companies, Fujitsu, Hitachi, and NEC, to build the central memory and CPU, as well as to participate in a joint venture, the Japan Software Company, to develop the operating system software. Two other companies, Toshiba and Oki, built peripheral equipment. (Mitsubishi opted not to join the project, and Matsushita withdrew from the computer market.) The resulting machine was later commercialized by Hitachi as the HITAC 8700/8800.

- The PIPS Project

In July 1981, AIST began what was to have been an eight-year, $100 million R&D project to develop a Pattern Information Processing System (PIPS). The research goals were threefold:

- development of new circuit materials and devices,
- development of subsystems for recognizing visual and speech patterns, and
- development of new types of information systems, e.g., parallel processing systems, associative information retrieval systems, and inference or learning systems.

Because of subsequent funding problems within the Japanese government, the project was "stretched out" two more years, coming to a conclusion in 1980. A prototype machine was completed at ETL, but it appears to have had little immediate impact upon the participating Japanese manufacturers. Rather the project should perhaps be regarded as an on-the-job training exercise in which a number of bright, young Japanese engineers were exposed to the state-of-the-art in the various technical areas involved. If such is the case, then this project (and the others described below) should not be judged in terms of the resulting prototype nor even the immediate commercial spinoffs (such as NEC's voice recognition unit) but rather in terms of the products developed by the project "alumni" in the ten years (or so) after the project was terminated.

- The 3.75 Generation Computer Project

As with the announcement of the its 360 series, IBM's announcement of its "3.5 generation" 370 series in 1970 caused considerable alarm in the Japanese computer industry. Rather than counter with yet another joint R&D project, however, MITI decided in 1972 to support the immediate development of commercial systems which were to be more advanced (in terms of price/performance ratio) than IBM's 370 systems. Hence, the appellation "3.75 generation" was adopted, connoting something "better" than the "3.5 generation" although not being so bold as to claim "fourth generation" technology.

Maybe MITI could not pry enough money out of MOF to spread among all six computer manufacturers, or maybe somebody in the Electronics Policy Division decided that six computer companies was too many. At any rate, MITI announced that, for purposes of developing the 3.75 generation computers, the Japanese companies would be paired off into three groups: Fujitsu and Hitachi, NEC and Toshiba, and Mitsubishi and Oki.

According to the initial plan, Fujitsu and Hitachi were to develop an IBM-compatible "M-series." Hitachi was to develop an M-170, approximately equal in performance to the IBM 370/158 (but lower in price), and an M-180, approximately equal to the IBM 370/168. Fujitsu was to develop the smaller M-160 and the very large-scale M-190, with approximately twice the performance of IBM's top-of-the-line 370/168. Apparently, MITI's plan called for at least the joint marketing, if not the joint production, of the M-series: a joint venture marketing company, Facom-Hitac, Ltd., was established in June 1974. However, marked differences in corporate operating style and years of intense rivalry simply could not be overcome: the (Hitachi) M-180 and (Fujitsu) M-190 were announced together in November 1974, but in the following September, Fujitsu announced an M-180II to compete with Hitachi's machine and Hitachi announced an M-160II to compete with Fujitsu's machine. Since that time, both firms have dropped any pretense of joint activity--with the notable exception of the 50-50 joint venture, Nippon Peripherals, Ltd., which develops and produces disk drives and other peripherals for both firms--and have competed toe-to-toe: Hitachi responded to Fujitsu's announcement of an M-200 in 1978 with its own M-200H, claimed to be slightly--10%--faster, and Fujitsu countered Hitachi's late-1980 announcement of an M-280H with a slightly faster M-380 in early 1981.

However, the other "marriages" arranged by MITI were somewhat more successful. NEC developed models 200, 300, 400, and 500 of the ACOS 77 series, while Toshiba developed models 600 and 700, and both companies cooperated in the development of the larger models 800 and 900. (Later, when Toshiba withdrew from producing the larger systems, NEC took over Toshiba's systems through the 60-40 joint venture, NEC-Toshiba Information Systems.) Similarly, Mitsubishi and Oki cooperated on the development of the COSMO series, Mitsubishi doing the CPU's and Oki the peripherals.

- The VLSI Project

IBM internal documents which were made public during the course of the antitrust suit brought by Telex in the early 1970s made mention of a "Future Series (FS)" then under development as the next generation of computer system. Because these documents did not divulge sufficient details about FS to enable Japanese companies to begin development of competitive systems, the Japanese elected to position their industry to respond to the eventual announcement of these systems by initiating a project to strengthen the technological base in semiconductors.

The Very Large Scale Integration (VLSI) project was begun in 1976 with the establishment of a VLSI Technology Research Association, comprised of the five major computer manufacturers--sans Oki--plus NTT laboratories and MITI/AIST's ETL. A total budget of some $323 million was allocated for the four-year life of the project, with about 60% of the costs being borne by the companies involved and the Japanese government providing the rest in the form of a conditional loan (hojokin) to the Association. The loan is repayable (without interest) if and when the participating companies realize a profit from the technologies developed under the project. (No such repayments have yet been made.) The technologies developed are covered by some 1,000 patents, of which about 95% are held by the Association and the remainder--those based on research done primarily by government employees--are owned by MITI. The former are available, subject to more-or-less automatic MITI approval, to the Association member companies for any use.

- The Software Technology Project

As the VLSI project was nearing a conclusion in 1978, various official and semiofficial announcements made frequent mention of a "software gap," implying that Japan had caught up with (and perhaps surpassed) the U.S. in semiconductor technology and that the only remaining area in which the U.S. held an advantage over Japan was in computer software. This set the stage for the announcement of a Software Technology project as the successor to the VLSI effort. [Subsequently MITI characterized the VLSI effort as "Phase I" and the Software Technology effort as "Phase II" of a larger project entitled "Promotion and Development of Technology for Next Generation (Fourth Generation) Computers."]

The participating companies--the "big six" plus Sharp and Matsushita--formed the Electronic Computer (Basic) Technology Research Association (ECSTRA) in July 1979. As before, the companies were to contribute half of the total funding of about $215 million over the five-year (1979-83) life of the project, with the balance provided by MITI in the form of a conditional loan like that provided to the VLSI association. However, beginning in July 1982, the government's share of the expenses was cut to 45% because of overall governmental budgetary constraints.

The project itself consists of two parts, one concerned with the development of operating system (OS) software, e.g., memory management, networking, data base management, and high-level languages--and the other concerned with developing peripherals and terminal equipment for handling Japanese language, including Kanji input and output and voice input. Oki, Sharp, and Matsushita are involved in only the second part of the project.

Note: This project should not be confused with an earlier (1976-81) "Software Automation" project funded by MITI through IPA. That project was considerably less ambitious in funding (about $30 million) if not in scope; the original goal was some kind of "automatic program generation," but this was scaled down to something more realistic, namely, the creation of a library of working aids for programmers. Nevertheless, these projects, as well as IPA's other activities, e.g., the development of a Software Maintenance Engineering Facility ($22.7 million for the period 1981-86) and the Software Technology Center, a permanent, general-purpose R&D facility established in 1981 with a current (1982) annual budget of $3.2 million--are all contributing to the overall goal: eliminating the "software gap."

- The New Function Elements Project

(Editor's Note: This project is discussed in detail in this issue by Barry Hilton in "Government Subsidized Computer, Software and Integrated Circuit Research and Development by Japanese Private Companies.")

In 1977, MITI established a "Long-term Industrial Technology Planning Committee" as a consultative group to the Director of AIST. Its report, issued October 1981, recommends that research in certain "next generation basic industries" be carried out in the 1980s to prepare for practical application in the 1990s. As a result, AIST has established a "Next Generation Industries (NGI) Basic Technology Planning Office" to oversee the recommended research programs. The New Function Elements Project is a part of the NGI Basic Technologies Research and Development Program.

One of the general goals of the Long-term Industrial Technology Program is expressed by MITI as "making greater contributions, through technology development, to the world community of nations," and another is ensuring that Japan will not be in the future, as it has been in the past, largely dependent upon imported technology. In order to try to accomplish these two goals simultaneously, MITI is seeking ways to incorporate into the projects a considerable amount of cooperation with foreign countries. According to the *Nihon Keizai Shinbun*, 13 September 1981, "it is said" that the research association formula was adopted in order to:

- "enable the member companies to display their autonomous nature more fully";
- "be able to respond more flexibly to requests for participation by foreign manufacturers"; and
- counter foreign--mainly, U.S.--criticisms that the Japanese government and Japanese private industry "are unitedly conducting research and development and are fostering advanced technology industries, as one body."

- The Supercomputer Project

(Editor's Note: Details of this project are presented in this issue by Barry Hilton in "Government Subsidized Computer, Software and Integrated Circuit Research and Development by Japanese Private Companies.")

Although the most powerful general-purpose computers now made in Japan have processing speeds--about 20-30 million floating-point operations per second (megaflops, or Mflops)--at least as great as the most powerful general-purpose computers made in the United States, two U.S. firms, Control Data Corporation and Cray Research, make somewhat specialized computers which are 10-20 times as powerful for such scientific applications as the simulation of atmospheric movements and the analysis of satellite-transmitted photographs. This project is aimed at giving Japan equivalent (if not superior) capabilities in scientific computers. It was publicly announced by MITI in July 1980 and is to last through 1989.

- The Fifth Generation Computer System Project

No other Japanese computer project has aroused as much attention--expressed variously as interest, enthusiasm, alarm, skepticism, and even derision--as this one. Officially titled "Research and Development Relating to Basic Technology for Electronic Computers," the project was announced in 1978 with the overall goal of "designing information processing systems to deal with the basic social problems Japan foresees for itself in the 1990s (such as low productivity in primary and tertiary industries, international competition, energy and resource shortages, and a rapidly-aging population)." It is expected to last through 1991. No budget figure for the entire project has been announced, but approximately $45 million is projected for 1981-84, all of it from MITI. (The half-million dollars expended by JIPDEC for the preliminary studies during 1979 and 1980 came from a private fund.)

The Institute for New Generation Computer Technology (ICOT), an endowed research foundation, was established in April 1982, and was assigned the task of accomplishing the project goals. Members of the Institute include the six major computer manufacturers plus Sharp and Matsushita. In addition, NTT, MITI's ETL, a number of other electronic firms, and various academic institutions have taken part in the preliminary studies for the project and are likely to have eventual roles in the research.

Foreign enterprises are also being invited to join. The ICOT project outline states:

> "As a research and development project involving advanced technologies from a wide range of fields, as well as from the viewpoint of its being an international contribution by Japan, the fifth generation computer project should be promoted through some form of international cooperation. Various formats are conceivable for such international cooperation but, based on experience gained during the past three years of basic technological development, the research and development work will be served best by extremely close interrelations among the various development themes. Thus, a form of cooperation that comes readily to mind is for interested governments or enterprises to promote original research and development at their own expense, periodically exchanging R&D achievements to the mutual benefit of all involved."

Although this project has been viewed with skepticism by many Western observers because of the ambitiousness of its goals and the vagueness of its plans, the potential importance of the project should not be underestimated. To be sure, there are significant risks involved in such an undertaking. The fact that the Japanese government is willing to tolerate those risks is one important aspect of this project's uniqueness. To quote ICOT again:

> "There is no precedent for this innovative and large-scale research and development anywhere in the world. We will therefore be obliged to move toward the target systems through a lengthy process of trial and error, producing many original ideas along the way."

Despite the risks, the potential payoffs are tremendous and the fact that the Japanese have dared to display their project plans to the world and to invite the cooperation of foreign nations suggests that the Japanese computer industry has come of age, at least in the eyes of the Japanese themselves. Moreover, the Fifth Generation Computer project is <u>qualitatively</u> different from those previous projects described above; the ICOT description states:

> "Unlike past technological developments aimed at attaining technologies already in existence in various overseas nations, fifth generation computer research and development is designed to provide Japan with the role of promoting the development of leading and innovative technologies <u>ahead of the rest of the world</u>." (Emphasis added.)

Mention should also be made of the role played by NTT in sponsoring projects which have contributed to the development of the Japanese computer industry. In the very earliest days, NTT initiated the development of computers based upon the parametron, a kind of solid circuit element invented in 1954 by Dr. Eiichi Goto of Tokyo University. Although this circuit element was eventually supplanted by the transistor, it was initially very attractive because it was far more stable than conventional vacuum tubes. Several parametron machines were built: NTT's Musashino-I, which began operation in April 1957;

the PC-1 and PC-2 at Tokyo University in 1958; and Hitachi's first commercial machine, the Hipac-101, which was exhibited in Paris in 1959.

In more recent years, NTT has supported the development of several series of large-scale computers for use in NTT's public computer services. Called DIPS, for "Dendenkosha Information Processing System"--NTT's full name in Japanese is "Nippon Denshin Denwa Kosha"; hence, "Dendenkosha"--the development of the original DIPS-0 prototype began in 1968, drawing upon current mode logic (CML) circuit technology from the AIST-sponsored Super High-Performance Computer project. (*Cf.* subsection above.) After its completion in 1971, Fujitsu, Hitachi, and NEC each built DIPS-I machines, under the leadership of NTT's Musashino ECL. Consisting of four CPU's (each roughly equivalent in processing power to an IBM 370/155) and 16 million bytes of (core) memory per system, these machines were put into commercial service in 1973 and were notable for their, (1) common machine language, and (2) standard I/O interface.

Subsequently, in 1974, NTT began work on a more powerful series of machines, the DIPS-11 series. Three different (albeit program compatible) models--numbered 10, 20, and 30--were developed by Hitachi, NEC, and Fujitsu (respectively). The largest (model 30) had roughly twice the processing power of an IBM 370/168. All were dual processor systems utilizing LSI emitter-coupled logic (ECL) and semiconductor memory with 4K bits per chip. These systems became operational in 1977, with a total of 26 CPU's being installed by year end.

In 1978, NTT announced a second DIPS-11 development program, resulting in models 15, 25, and 35, which have two-three times better performance than the corresponding older models. These use 64K memory chips and include separate Communication Control Processors and File Control Processors, each labeled DIPS-11, Model 5. Prototypes were completed in 1980 and 1981.

In mid-1981, NTT also announced the DIPS-11, Model 45, a dual processor system capable of processing some 30 million instructions per second. Developed by Fujitsu, this machine is virtually identical to the M-382 computer announced commercially by Fujitsu at about the same time. The question therefore arises: To what extent was Fujitsu's M-382 development subsidized by NTT R&D funds? Also: To what extent has the development of computer systems by other Japanese manufacturers been subsidized (or, at least aided) by the DIPS program? In addition, NTT is reported to have under development a "supercomputer" equivalent to or greater in processing power than the Cray-1. Hence, a further question: What relationship, if any, is there between this effort, the MITI-sponsored project described above, and the "in-house" supercomputer development efforts of the various Japanese computer companies? In a broader context: To what extent does NTT's R&D budget (which is reviewed and approved by the Japanese Diet) serve as a somewhat concealed supplement to the more publicly-visible research programs of the Japanese government?

SOME ADDITIONAL OBSERVATIONS

- Japanese Industrial Structure

It has been suggested that the Japanese use the following paradigm in developing a particular industrial sector:

CREDIBILITY - PROFITABILITY - CREATIVITY.

To explain this more fully: When the Japanese wish to penetrate a particular area of world business, they begin by offering a product (or service) of good--even outstanding--quality so as to quickly attain a good reputation, thereby establishing themselves as a viable alternative to other competitors who may already be in the market. (The Japanese are acutely aware of the "cheap Japanese copy" stigma and have worked very hard to overcome it.) In order to achieve market penetration while building the reputation for quality, they are likely to incur significant short-term losses, but these are often underwritten by special loans arranged by the Japanese government. (The 3.75 Generation Computer project is a good example of this.) The obvious next step is to eliminate these losses, to achieve profitability. Here, the Japanese approach seems to be straightforward: economies of scale and efficiency in operation, obtained through hard-working, well-managed organizations. (Some observers would claim that this undertaking is helped considerably by Japanese protection of their domestic markets, which enables them to easily obtain economies of scale and--it is suspected, though it is well-nigh impossible to prove--engage in two-tier pricing.) Finally, they begin to introduce innovations, usually of a incremental, "evolutionary" kind rather than sweeping, "revolutionary" changes which run the risk of nonacceptance in the marketplace. The strategy here seems to be to exploit any weaknesses in the competition and thereby to consolidate their place in the market.

Some observers question the ethics of some of the tactics used, but the Japanese could (but do not--at least publicly) reply, "Whose ethics?" One undeniable fact is that, throughout the three-step process outlined above, the Japanese most assuredly "do their homework." Another is that they work with single-minded dedication.

In the case of computers, the Japanese first sought credibility through cross-licensing arrangements with U.S. firms. Entered into during the early 1960s, these permitted Japan to produce local versions of American designs, to utilize (at least some) American software, and to advance "down the learning curve" more rapidly than they might have if they had tried to do everything independently. Further credibility was attained in the 3.75 generation development in the mid-1970s by utilizing advanced semiconductor technology which enabled the Japanese to make such claims as: more gates (or bits) per chip, greater raw processing power, and better (hardware) price/performance than comparable U.S. computers.

It is now obvious that the Japanese computer industry has moved beyond the "credibility" phase. Japanese computer hardware has a world-wide reputation for performance and reliability--and there has been no mention of a "software gap" in the Japanese trade press for some time. Their transition into the "profitability" phase may have come slower than they had planned, largely because of IBM's competitive responses to the Japanese challenge, but they are now turning out computers as a prodigious rate, thereby (presumably) realizing considerable economies of scale and, hence, profits.

One factor that has often been pointed out in this regard is the vertical integration of Japanese computer firms: all of them also produce semiconductors and several of them are major semiconductor suppliers to the world. This is in contrast to the U.S. where, although most computer manufacturers have at least some in-house semiconductor development and production capability, only a few firms market both semiconductor chips and computers, and none of them sell the range of products available from Japanese companies.

In the future, however, the Japanese may gain even greater advantage from a different kind of integration: that resulting from the fact that several of their major computer firms are also major makers of telecommunications equipment. Much has already been written about this of late in the U.S. trade press, perhaps occasioned by the industry restructuring inherent (explicitly) in the AT&T and (implicitly) in the IBM antitrust settlements. However, this may have com[illegible]oo late for the U.S. firms to position themselves properly to compete against the Japanese in emerging "communications" markets. (One should take note of the "Computers and Communications" theme of NEC advertisements which have been appearing in U.S. business periodicals for a couple of years to realize how far along the Japanese are in this regard). There are further impediments arising from interminable bickering and delays in clearing the legislative and regulatory thicket in the U.S., but the Japanese face similar problems, both domestically and internationally.

Two other kinds of structural integration which may give the Japanese considerable world-wide competitive advantage in the not-too-distant future are evident in the capabilities and experience of some Japanese computer makers, (1) in capital goods, and (2) in consumer products. In the latter area, the unfortunate experiences of U.S. semiconductor firms in digital watches and the very tentative marketing actions by IBM, DEC, and others in personal computers reveal the potential significance of the lack of such corporate experience in U.S. computer firms.

It is in these three kinds of structural integration, namely, computers plus

- telecommunications,
- capital goods, and
- consumer products,

coupled with the integrated semiconductor development and production capabilities--that the Japanese computer industry has a strong base to begin the innovation that will mark passage into the "creativity" phase. The (1981) report of AIST's "Long-term Industrial Technology Planning Committee" spells it out for all to see: the Japanese computer industry is not regarded as an end (or entity) in itself, but rather computers are viewed as the keystone in structuring a postindustrial society that will remain viable and competitive--indeed, probably become more so--through the 1990s.

- Japanese Creativity

There are a considerable number of people in the United States these days who seem to be fond of telling anybody who will listen that the Japanese lack the creativity necessary to assume world leadership in computers (or in any other area of high technology). However, one wonders if such proclamations are only a compulsive attempt to shore up our sagging self-confidence in the face of what is viewed as a formidable threat to our continued prosperity and self-esteem. The gist of their arguments (against the possibility of creativity existing in Japan) seems to boil down to two premises:

- individuality--that is, ego-expression--is essential in creativity; and
- the Japanese society will not tolerate the eccentricity that accompanies creative genius.

I frankly question the validity of either assertion. As for the first one, I wonder whether eccentricity is really a necessary or sufficient condition for genius, or whether it is something Western societies tolerate--expect?--in those persons they elect to identify as geniuses. Recalling Einstein's characterization of genius as "one percent inspiration and ninety-nine percent perspiration," I wonder whether the highly disciplined and work-oriented Japanese society might actually be a superior incubator of genius. Moreover, my own experience with the Japanese society has exposed me to persons who, while not particularly eccentric, have been permitted by Japanese institutions to make exceptional contributions, even of a personal nature. These people are (rightfully) proud of what they have done themselves, but they also recognize that it was probably circumstance more than individual merit that led to their "nail" not having been "hammered down."

Furthermore, there is the question of what else is needed in addition to an occasional genius or two to create and--what is more important--maintain "successful" institutions of any kind. One has only to consider the shortcomings (as well as the contributions) of past and present inventors, financiers, politicians, artists, and other outstanding people to realize that, although "creativity" of some kind may be important in establishing new ideas and the institutions which embody them, a very different kind of aptitude--call it "salesmanship" or "charisma" if you will--is necessary to gain acceptance of new ideas in others, and a very different kind of activity--call it "nurturance" or "management" or whatever--is necessary for the growth and sustenance of the resulting organizations which amplify the impact of new concepts beyond the capabilities of one person. Again, the question arises: Which culture, Japanese or Western, is best suited to producing and developing these other ingredients so essential for world technological leadership?

Finally, one must look at the record. Although the Japanese have not been flawless in their realization of the various industrial and societal goals they have set for themselves, their batting average certainly has been impressive. Why, then, should we regard the Japanese computer industry as being any different? Why should we expect that, in this instance, they will fail to eventually achieve the dominance to which they now openly aspire? As Shakespeare put it: "The answer lies not in the stars, but in ourselves."

ACKNOWLEDGEMENTS

The information contained in this paper has been gleaned over the past twenty-plus years from sources to numerous to mention: assorted articles which have appeared in the trade press, various reports and descriptive brochures, and especially, numerous interviews and discussions with knowledgeable persons in all parts of the world. In order to avoid the risk of offending anyone by inadvertently omitting his or her name or by mentioning the name of someone who prefers to remain anonymous, no attempt will be made to identify all those persons here.

However, mention should rightly be made of four sources from which the author has drawn extensively, both as to fact and as to impression.

REFERENCES

"Government Subsidized Computer, Software and Integrated Circuit Research and Development by Japanese Private Companies." Barry Hilton. *ONR Scientific Bulletin, 7* (4), 1 (1982).

MITI and the Japanese Miracle. Chalmers Johnson. Stanford University Press, 1982.

Japan: The Government-Business Relationship. Eugene J. Kaplan. U.S. Department of Commerce, 1972.

"The Japanese Computer Industry: Its Roots and Development." Koji Kobayashi. *Proc. 3rd USA-Japan Computer Conference,* San Francisco, October, 1978, pp. ix-xx.

1983, continued

Date	Title	Site	For information, contact
February 10-12	6th Australian Computer Science Conference	Sydney, Australia	Professor J.M. Bennett Basser Department of Computer Science University of Sydney Sydney, N.S.W. 2000
February 17-18	2nd Annual Meeting of the Australia and New Zealand Society for Cell Biology and International Symposium	Sydney, Australia	Dr. A. Sibatani CSIRO Unit of Cellular and Molecular Biology Genetics Research Laboratories P.O. Box 184 North Ryde, N.S.W. 2216
March 27-31	1983 International Power Electronics Conference	Tokyo, Japan	Professor N. Sato Department of Electrical and Electronics Engineering Tokyo Institute of Technology Ohokayama, Meguro-ku Tokyo 152
March (tentative)	Conference on Coastal Engineering	Queensland, Australia	Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
April 20-22	First International Symposium on Molten Salt Chemistry and Technology	Kyoto, Japan	Dr. Y. Ito Secretary General Kyoto International Conference Hall Takara-ike, Sakyo-ku Kyoto 606
May 10-12	International Productive Symposium	Tokyo, Japan	Japan Productivity Center 3-1-1, Shibuya Shibuya-ku, Tokyo 150
May 16-20	The 5th National School and Conference on X-ray Analysis	Melbourne, Australia	Dr. R. A. Coyle X-ray Analytical Association, New South Wales Institution of Technology P.O. Box 90, Parkville Victoria 3052

1983, continued

Date	Title	Site	For information, contact
May 16-20	Annual Scientific Meeting of the Australian Society for Microbiology	Brisbane, Australia	The National Secretary Australian Society for Microbiology Inc. 191 Royal Parade Parkville, Victoria 3052
May 29-June 3	International Conference on Fluidization	Mie, Japan	Professor D. Kunii Department of Chemical Engineering Faculty of Engineering University of Tokyo 7-3-1, Hongo, Bunkyo-ku Tokyo 113
May (tentative)	36th Annual Metals Congress	Pt. Kembla, Australia	Australian Institute of Metals P.O. Box 1144, Wollongong, N.S.W. 2500
June 27-30	4th International Conference on Integrated Optics and Optical Fiber Communication-IOOC'83	Tokyo, Japan	IOOC '83 Business Center for Academic Societies Japan 2-4-16, Yayoi, Bunkyo-ku Tokyo 113
June (tentative)	Biomedical Engineering Conference	Australia (undecided)	The Conference Manager The Institute of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
July 4-5	4th Topical Meeting on Gradient Index Optical Imaging Systems	Kobe, Japan	Nunoi Office Azabudai UNI-house 504 1-1-20, Azabudai Minato-ku, Tokyo 106
July (tentative)	Environmental Engineering Conference	Australia (undecided)	The Conference Manager The Institute of Engineers Australia 11 National Circuit Barton, A.C.T. 2600
August 1-7	International Association for Dental Research	Sydney, Australia	Mr. Scott Gotjamanos Department of Pathology Perth Medical Center Verdon Street Nedlands, W.A. 6009

Date	Title	Site	For information, contact
August 14-19	International Solar Energy Congress	Perth, Australia	Mr. P. Driver Honorary Secretary P.O. Box 123 Nedlands, W.A. 6009
August 14-19	Computers in Engineering	Australia (undecided)	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
August 17-24	The 4th International Congress of Plant Pathology	Melbourne, Australia	Mr. B. Price Victorian Plant Research Institute Department of Agriculture Victoria, Swan Street Burnley, Victoria 3121
August 21-25	Thermal Physiology Symposium	Sunshine Coast, Australia	Mr. J.R.S. Hales CSIRO Division of Animal Production P.O. Box 114 Eastwood, S.A. 5063
August 21-26	The Ninth International Congress of Heterocyclic Chemistry	Tokyo, Japan	Dr. T. Kametani Hoshi College of Pharmacy 2-4-41, Ebara Shinagawa-ku, Tokyo 142
August 21-27	The 5th International Congress of Immunology	Kyoto, Japan	The Japanese Society for Immunology Institute of Virus Research Kyoto University Kawaracho, Shogoin Sakyo-ku, Kyoto 606
August 22-26	7th Australian Symposium on Analytical Chemistry	Adelaide, Australia	Mr. Don Patterson Honorary Secretary AMDEL, P.O.Box 114 Eastwood, S.A. 5063
August 25-September 1	Conference of the International Union of Forest Research Organization	Melbourne, Australia	Mr. B. Cumberland Forestry Branch Department of Primary Industry Camberra, A.C.T. 2600

1983, continued

Date	Title	Site	For information, contact
August 27	Symposium Commemorating the 100th Anniversary of the Mount Krakatau Eruption	Jakarta, Indonesia	Dr. Didin Sastrapradja Indonesian Institute of Sciences LIPI, JL Teuku Chik Ditiro 43 Jakarta
August 27-31	The 25th International Geographical Congress	Sydney, Australia	Australian Academy of Science P.O. Box 783 Canberra, A.C.T. 2601
August 26-September 2	The 18th International Ethological Conference	Brisbane, Australia	Professor E. McBride Deppartment of Psychology University of Queensland St Lucia, Queensland 4067
August 28-September 2	The 29th International Congress of Physiology	Sydney, Australia	Australian Academy of Science P.O.Box 783, Canberra A.C.T. 2601
August 28-September 3	The 3rd International Mycological Congress (IMC 3)	Tokyo, Japan	Professor K. Tsubaki Institute of Biological Sciences The University of Tsukuba Sakura-mura, Ibaraki 305
August 29-September 3	Fourth International Symposium on Water-Rock Interaction	Tottori, Japan	Professor H. Sakai Institute of Thermal Spring Research Okayama University Misasa, Tottori 682-02
August 30-September 1	International symposium on Measurement and Processing for Indirect Imaging	Sydney, Australia	Dr. R.H. Frater, Chairman National Committee for Radio Science CSIRO Division of Radio Physics P.O.Box 76 Epping, N.S.W. 2121
August (tentative)	Hydraulics and Fluid Mechanics Conference	Newcastle, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600

Date	Title	Site	For information, contact
September 5-7	International Symposium on Guanidino Compounds	Tokyo, Japan	Institute of Neurobiology Medical School Okayama University Okayama, Japan
September 5-10	IUTAM Symposium on Turbulence and Chaotic Phenomena in Fluids	Kyoto, Japan	Professor T. Tatsumi Department of Physics Faculty of Science Kyoto University Sakyo-ku, Kyoto 606
September 12-16	The International Ion Engineering Congress	Kyoto, Japan	Professor T. Takagi Ion Beam Engineering Experimental Laboratory Kyoto University Sakyo-ku, Kyoto 606
September 19-23	The 12th World Energy Conference	New Delhi, India	Dr. R.J. Ramdebough 1620 Eye Street Suite 808 Washington, D.C. 20008
September 22-26	The 4th Asian and Australian Conference ISRT (International Society of Radiologic Technologists)	Tokyo, Japan	Mr. Lucky Morimoto International Department The Japan Association of Radiologic Technologists 26-7, Shinkawa 1-chome Chuo-ku, Tokyo 104
October 2-5	The 3rd International Display Research Conference	Kobe, Japan	Japan Convention Services, Inc. Nippon Press Center, 8F 2-1, Uchisaiwai-cho 2-chome, Chiyoda-ku Tokyo 100
October 17-21	1983 ICE (International Electrotechnical Commission) General Meeting in Tokyo	Tokyo, Japan	Japan Standards Association 4-1-24, Akasaka Minato-ku, Tokyo 107
October 23-28	1983 Tokyo International Gas Turbine Congress	Tokyo, Japan	The Organizing Committee of 1983 Tokyo International Gas Turbine Congress Sansei International, Inc. Showa Building, 1-7-5 Akasaka, Minato-ku, Tokyo 107

Date	Title	Site	For information, contact
October 24-28	28th Annual Scientific Meeting of the Royal College of Pathologists of Australia	Melbourne, Australia	The Secretariat, The Royal College of Pathologists of Australia 82 Windmill Street Sydney, N.S.W. 2000
October (tentative)	The 8th International Conference on Calcium Regulating Hormone	Kobe, Japan (tentative)	Professor T. Fujita 3rd Division Department of Medicine School of Medicine Kobe University 7-13, Kusunoki-cho Ikuta-ku, Kobe 650
October 29-November 3	The 71st FDI Annual World Dental Congress (Federation Dentaire Internationale)	Tokyo, Japan	Japan Dental Association (Japanese Association for Dental Science) 4-1-20, Kudan-kita Chiyoda-ku, Tokyo 102
November (tentative)	Conference on Microprocessors	Australia (undecided)	The Conference Manager The Institute of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
November (tentative)	Metal Structures Conference	Brisbane, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
December (tentative)	The 12th International Laser Radar Conference	Melbourne, Australia	Dr. C. Platt, CSIRO Division of Atmospheric Physics P.O. Box 77, Mordiattoc Victoria 3195
December (tentative)	Applied Mechanics Conference	Australia (undecided)	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
December (tentative)	Annual Meeting of the Australian Society for Immunology	Perth, Australia	Executive Officer Australian Society for Immunology P.O. Box 206 Nedlands, W.A. 6009

1983, continued

Date	Title	Site	For information, contact
Undecided	The 13th International Congress of Chemotherapy	Melbourne, Australia	Dr. B. Stratford St. Vincent's Hospital 59 Victoria Parade Fitzroy, Victoria 3065

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Date	Title	Site	For information, contact
April 3-5	Tele Conference (tentative name)	Tokyo, Japan	Data Communications Department Kokusai Denshin Denwa Company, Ltd. 2-3-2, Nishi-Shinjuku Shinjuku-ku, Tokyo 160
February 12-16	14th Australian Polymer Symposium	Ballarat, Australia	Dr. G.B. Guise P.O. Box 224 Belmont, Victoria 3216
February (tentative)	International conference on Mesoscale Meteorology	Australia, (undecided)	Royal Meteorological Society Australian Branch P.O. Box 654 Melbourne, Victoria 3001
May (tentative)	World Computing Services Industry Congress 4	Tokyo, Japan	Japan Software Industry Association Kikai Shinko Kaikan 3-5-8, Shiba-koen Minato-ku, Tokyo 105
May (tentative)	5th International Soils Expansion Conference	Adelaide, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
August 24-30	5th International Congress on Mathematical Education	Adelaide, Australia	Dr. John Mack Department of Mathematics University of Sydney N.S.W. 2006
August 24-September 1	The 3rd International Congress on Cell Biology	Kyoto or Kobe, Japan	Japan Society for Cell Biology Shigei Medical Research Institute 2117 Yamada Okayama 701-02

Date	Title	Site	For information, contact
August 26-September 1	International Conference on the Photochemical Combustion and Storage of Solar Energy	Osaka, Japan	The Society of Kinki Chemical Industry 1-8-4, Utsubo-hommachi Nishi-ku, Osaka 550
August (tentative)	The 9th International Conference on Raman Spectroscopy	Tokyo, Japan	Professor M. Tasumi Department of Chemistry Faculty of Science University of Tokyo 7-3-1, Hongo Bunkyo-ku, Tokyo 113
September 2-7	International Symposium on Snow and Ice Processes at the Earth's Surface	Sapporo, Japan	The Institute of Low Temperature Science Hokkaido University 8-chome, Kita 19-Jyo Kita-ku, Sapporo 060
September 3-5	1st International Conference on Technology of Plasticity	Tokyo, Japan	Japan Society for Technology Plasticity Torikatsu Building 3F 5-2-5, Roppongi Minato-ku, Tokyo 106
September 11-13	10th International Conference of IMEKO TC-3 (International Measurement Confederation)	Kobe, Japan	Professor T. Ono Department of Mechanical Engineering College of Technology University of Osaka 4-804, Umemachi, Mozu Sakai, Osaka 591
October 16-18	1984 International Symposium on Electromagnetic Compatibility (EMC)	Tokyo, Japan	Professor T. Takagi Department of Electrical Communications Faculty of Engineering Tohoku University Sendai, Miyagi 980
November 22-23	Technology Past, Present, and Future	Melbourne, Australia	Executive Officer Australian Academy of Technological Sciences Clunies Ross House 191 Royal Parade Parkville, Victoria 3052

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Date	Title	Site	For information, contact
February 11-14	International Symposium on Characterization and Analysis of Polymers	Melbourne, Australia	Polymer 85 Royal Australian Chemical Institute 191 Royal Parade Parkville, Victoria 3052
March (tentative)	Annual National Conference of the Institution of Engineers, Australia	Melbourne, Australia	LtCol. J.A. McDonald Secretary, Victoria Division Institute of Engineers Australia National Science Center 191 Royal Parade Parkville, Victoria 3052
May 20-24	3rd Conference on Steel Developments	Melbourne, Australia	Australian Institute of Steel Construction P.O. Box 434 Milsons Point, N.S.W. 2061
August (tentative)	Coastal Engineering Conference	Melbourne, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
Autumn (tentative)	11th International Teletraffic Congress ITC-11	Kyoto, Japan	TIC-11 Committee Musashino Electrical Communication Laboratory 3-9-11, Midorimachi Musashino, Tokyo 180
August (tentative)	International Association Hydraulic Resources Conference	Melbourne, Australia	The Conference Manager The Institution of Engineers, Australia 11 National Circuit Barton, A.C.T. 2600
October 15-18	International Rubber Conference	Kyoto, Japan (tentative)	The Society of Rubber Industry, Japan Tobu Building, 1-5-26 Motoakasaka, Minato-ku Tokyo 107

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Date	Title	Site	For information, contact
May 11-17	Congress of the International Society of Haematology and the International Society of Blood Transfusions	Sydney, Australia	Dr. I. Cooper, President Haematology Society of Australia Cancer Institute 481 Little Londsdale Street, Melbourne Victoria 3001
Undecided	International Microbiological Congress	Perth, Australia	Australian Academy of Science P.O. Box 783, Canberra A.C.T. 2601
Undecided	International Institute of Welding Annual Assembly 1986	Tokyo, Japan	Japan Welding Society 1-11, Sakuma-cho, Kanda Chiyoda-ku, Tokyo 101

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